JANUARY 1958

Agricultural Engineering

The Journal of the American Society of Agricultural Engineers

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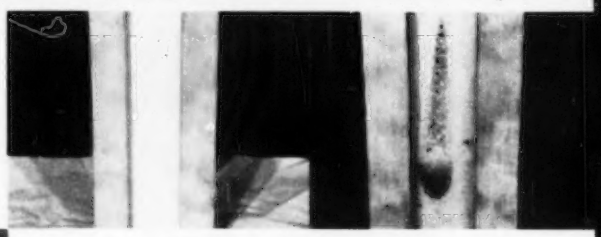

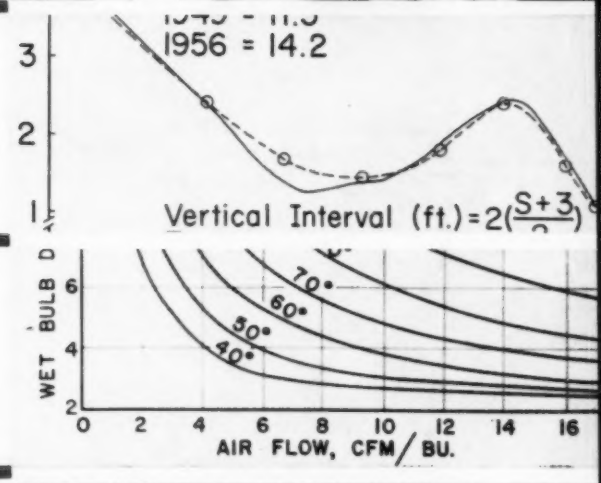

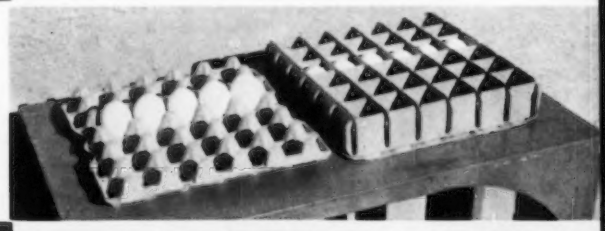

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How Armco Stainless Steel Provides BALANCED DESIGN in Turkey Waterers

Turkey waterers are often subjected to highly corrosive chemicals that are either present in the water or added to benefit the birds. The chemicals attack the inner liner and trough, causing early failure of these parts.

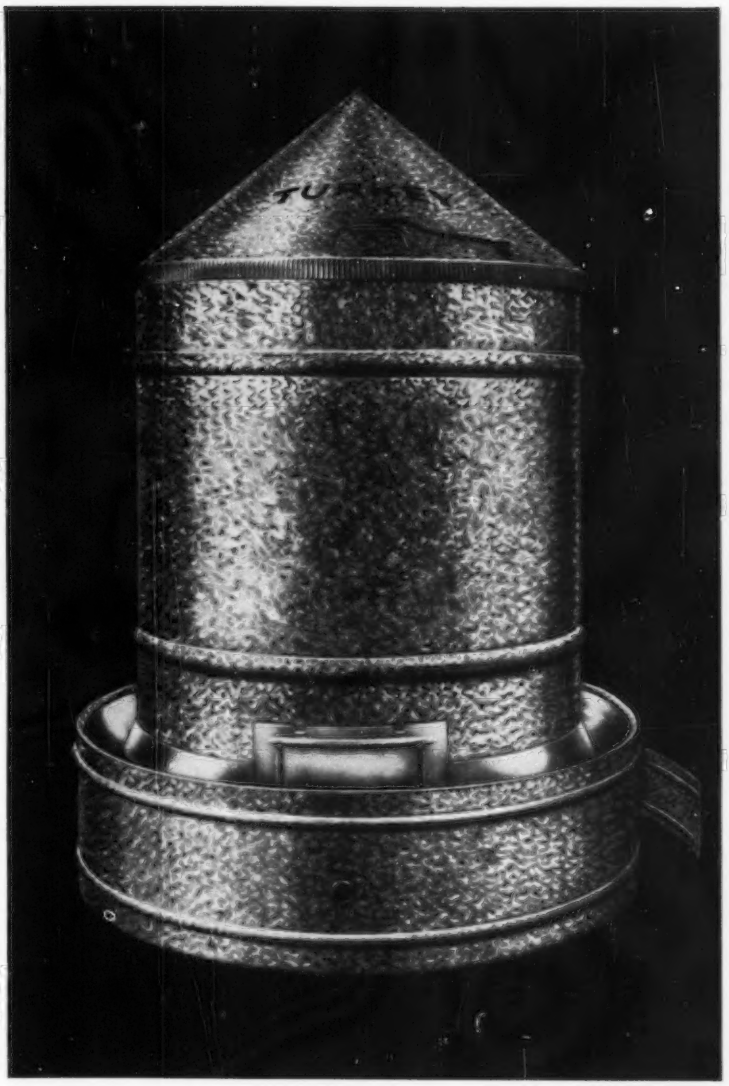
This is why one large manufacturer of poultry equipment provides inner liners and troughs made of Armco Stainless Steel as optional equipment on turkey waterers for growers who have the problem of chemical corrosion.

Balanced Design

Stainless steel inner liners and troughs assure longer service life for the entire waterer — provide balanced design. In addition, stainless steel troughs are easy to keep clean—require little or no maintenance.

If early failure of some part on your equipment is shortening the service life of the entire unit, it may pay you to consider stainless steel for the key part. It's the practical way to gain *balanced design*. Furthermore, longer service life is a powerful sales point with today's cost conscious farmers.

Write us at the address below about your design problems. Our engineers will gladly consult with you on the long range economy of Armco Stainless Steel.



Turkey waterer inner liners and troughs made of Armco Stainless Steel provide balanced design, extend service life of the entire unit.

ARMCO STEEL CORPORATION

1398 Curtis Street, Middletown, Ohio • Sheffield Division • Armco Drainage & Metal Products, Inc. • The Armco International Corporation

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Agricultural Engineering

Established 1920

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1958 Nuclear Congress

THE 1958 Nuclear Congress will be held at the International Amphitheatre, Chicago, Ill., March 17-21. It is sponsored by the American Nuclear Society and over thirty national engineering and scientific societies (including ASAE), and coordinated by Engineers Joint Council. The Congress is an assembly of the 4th Nuclear Engineering and Science Conference, the Atomic Energy Management Conference, the 6th Hot Laboratories and Equipment Conference, and the Atomfair.

The tentative program of the Nuclear Engineering and Science Conference will consist of approved papers to be presented during several session periods. The scheduled sessions cover the commercial use of radioactive tracers; reactor component development, fabrication and testing; standardization, codes and licensing; reactors for process heat and radiation; production and miscellaneous application of radioisotopes; reactor operation and maintenance; fuel, control, moderator and coolant materials; experimental power reactors and advanced concepts; health physics and instrumentation; reactor physics; temperature measurements and high temperature instrumentation; waste treatment and disposal; and reactor plant instrumentation.

Other sessions to be included in the program are on reactor location and safety; thermal and mechanical design; reactor control instrumentation; progress in commercial power reactor development; reactor plant materials; nuclear education and training; fuel element development, fabrication and testing; reactor systems analysis; research and test reactors and critical assemblies; chemical reprocessing; water contamination and treatment; and reactor shielding and containment.

Papers to be presented that may be of greatest interest to ASAE members include discussions on tracer studies of fungicidal action, by R. W. Greenlee, R. S. Davidson, H. T. Kemp, and M. M. Baldwin; radio-active tracers in extreme pressure lubrication, by E. H. Loeser, R. C. Wiquist, and S. B. Twiss; location of leaks with radioisotopes in multi-walled tanks, by W. F. Sullivan; and the use of Tritium as an ionizing source in instruments, by G. F. Vanderschmidt, J. R. Roehrig, and J. C. Simons, Jr.

Other papers which should be of interest to ASAE members cover the effect of nuclear radiation on the behavior of cellulose and cellulose derivatives, by Otto Teszler and H. A. Rutherford; nuclear training programs for industry personnel, by S. J. Harris; the absorption of radioactive substances on waterborne and consolidated materials, by F. B. Barker; and a field test of the movement of radioactive cations through an underground formation, by B. B. Ewing.

Programs for the 1958 Nuclear Congress may be obtained from ASAE Headquarters, St. Joseph, Mich.

IMPORTANT NEWS!

HERCULES TO MAKE LYCOMING-DESIGN ENGINES

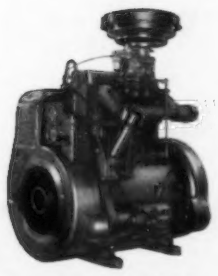
TO ENGINE USERS EVERYWHERE----

THE FAMOUS LYCOMING AIR-COOLED INDUSTRIAL ENGINE LINE, TWO AND FOUR CYLINDERS, WILL NOW BE MADE BY HERCULES MOTORS CORPORATION. THIS FORWARD STEP ENABLES HERCULES TO OFFER A PROVED, DEPENDABLE AIR-COOLED ENGINE IN ADDITION TO ITS WATER-COOLED ENGINES, GIVING USERS A WIDE SELECTION OF VALVE-IN-HEAD ENGINES IN THE DISPLACEMENT RANGE FROM 88 TO 339 CU. IN.

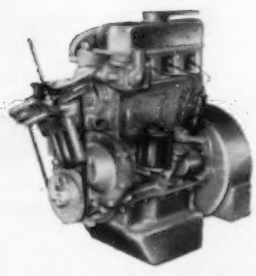
THE HERCULES REPUTATION FOR RELIABILITY, QUALITY MANUFACTURING AND ENGINEERING, PLUS THE COMBINED DISTRIBUTOR ORGANIZATIONS FOR BOTH LYCOMING AND HERCULES, ASSURE PRESENT CUSTOMERS AND POTENTIAL USERS MUCH BROADER SPREAD OF IMPROVED SERVICE FACILITIES.

FULL SCALE PRODUCTION OF THE LYCOMING AIR-COOLED ENGINE AT HERCULES CANTON OHIO PLANT SCHEDULED FOR EARLY 1958. YOUR INQUIRIES WILL BE APPRECIATED AND WILL BE PROMPTLY AND COURTEOUSLY ANSWERED.

W.L. PRINGLE, PRESIDENT
HERCULES MOTORS CORPORATION
CANTON 2, OHIO

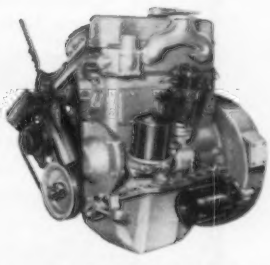


Lycoming-Design Hercules Two Cylinder Air-Cooled Industrial Gasoline Engine, Displacement 88 cu. in.



Hercules Three Cylinder Water-Cooled Gasoline (or Diesel) Engine, Displacement 130-149-169 cu. in.

Lycoming-Design Hercules Four Cylinder Air-Cooled Industrial Gasoline Engine, Displacement 176 cu. in.



Hercules Four Cylinder Water-Cooled Diesel (or Gasoline) Engine, Displacement 173-198-226 cu. in.

Hercules engines are also available in six cylinder 260, 298 and 339 cu. in. valve-in-head water-cooled types.

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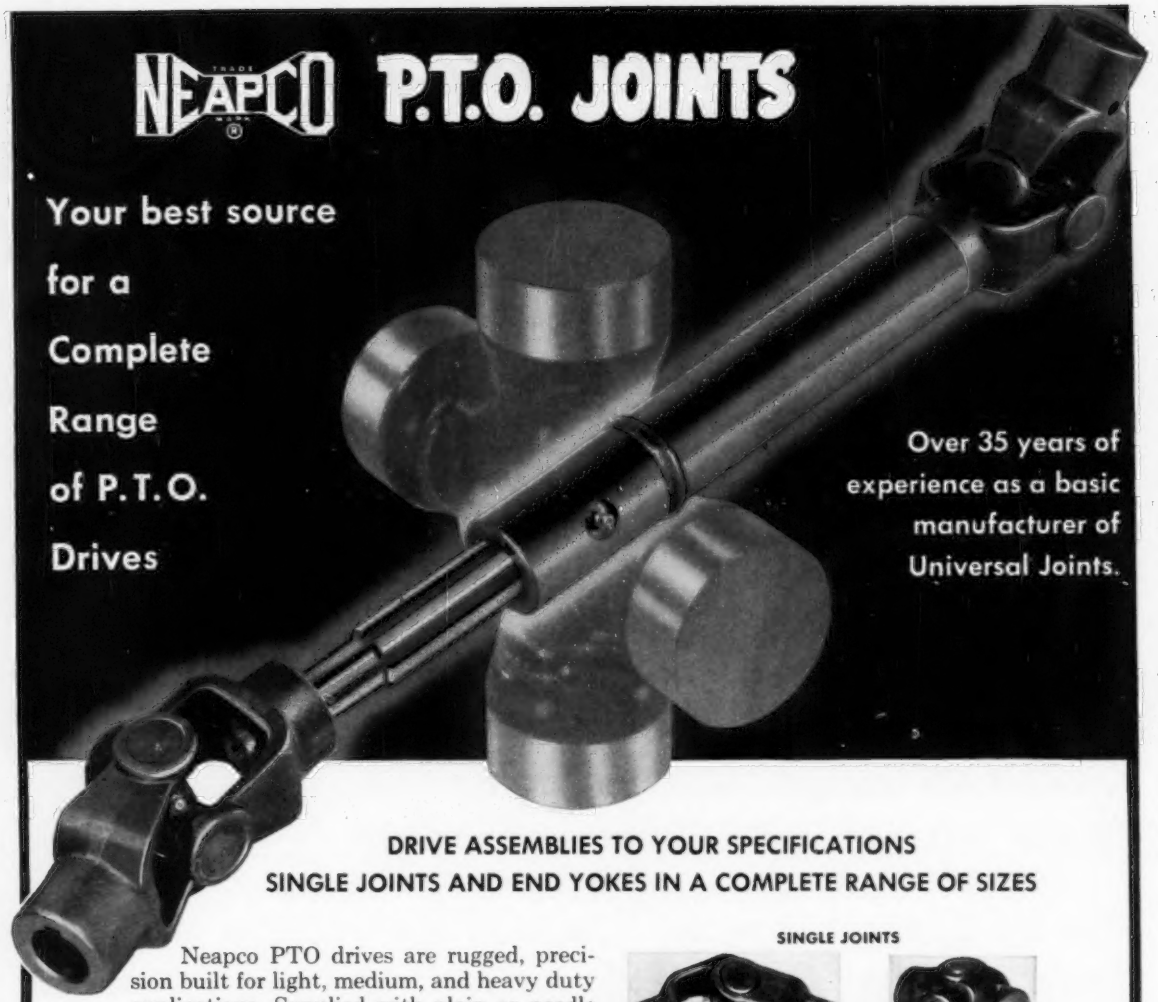
Your best source for a Complete Range of P.T.O. Drives



Over 35 years of experience as a basic manufacturer of Universal Joints.

DRIVE ASSEMBLIES TO YOUR SPECIFICATIONS
SINGLE JOINTS AND END YOKES IN A COMPLETE RANGE OF SIZES

Neapco PTO drives are rugged, precision built for light, medium, and heavy duty applications. Supplied with plain or needle bearing Journal Assemblies in a wide variety of yoke combinations.

Neapco Joints and Drive Assemblies are now standard equipment for many leading manufacturers of Dump Bodies, Hoists, Elevators, Loaders, Lime Spreaders, Steering Controls, Auxiliary Drives, Balers, Mowers, and others.

Neapco is a well known, experienced source, able to fill the Universal Joint and Drive Line requirements you have.

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Write for free engineering literature, or send us your specifications. Neapco will also design assemblies to meet your requirements.

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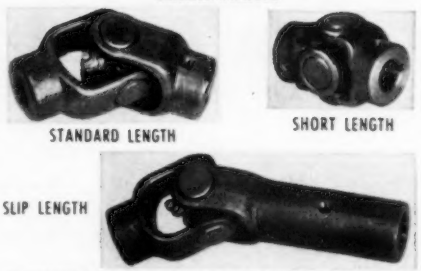
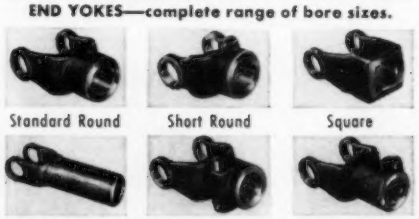


STANDARD LENGTH

SHORT LENGTH

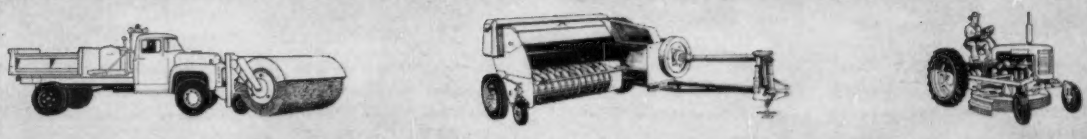
SLIP LENGTH

END YOKES—complete range of bore sizes.

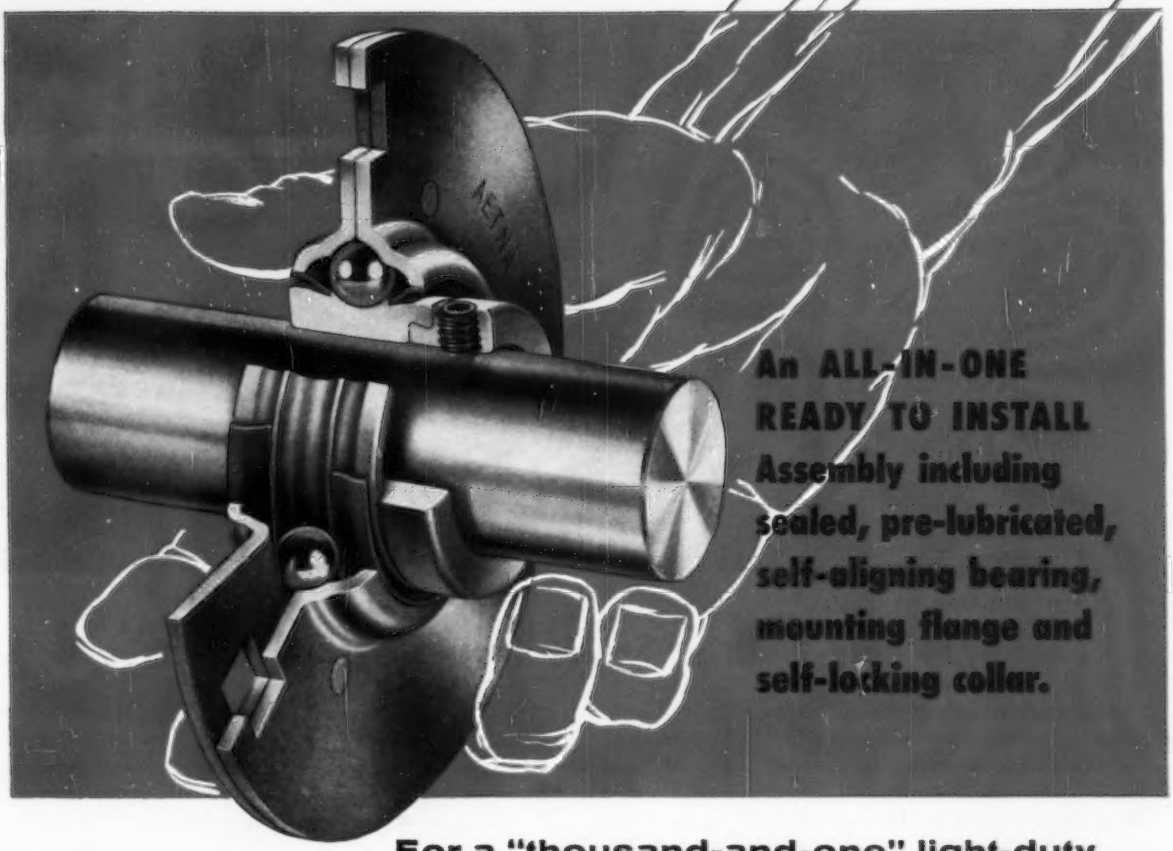


Standard Round | Short Round | Square

Slip Length | Quick Disconnect | Clamp Type



Isn't this the bearing bargain you've been waiting for?



For a "thousand-and-one" light-duty, moderate speed applications.

Aetna *PACKAGED* Adapter Bearings provide the ideal answer wherever anti-friction is the need and low-cost the problem.

These rugged, compact, economy-priced *PACKAGE* units mount easily, quickly, wherever shafts can be supported, including mounting on sheet metal or any semi-rigid structural members. They are pre-lubricated for life—can be entirely forgotten once installed. Adapting them to your current or projected equipment designs requires little, if any, engineering alterations. Because of the costly machining and assembly time they save, their cost compares with the use of bushings or plain sleeve bearings—and you gain the advantages of pre-lubricated anti-friction units. Available in 8 standard shaft sizes: ½" to 1¼"

Aetna offers you America's widest choice of ball bearing *PACKAGE* units—all described in detail in Catalog AG-57. Write for a copy or phone the Aetna representative listed in the yellow pages.

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Anti-friction Consultant to Leading Original Equipment Manufacturers since 1916

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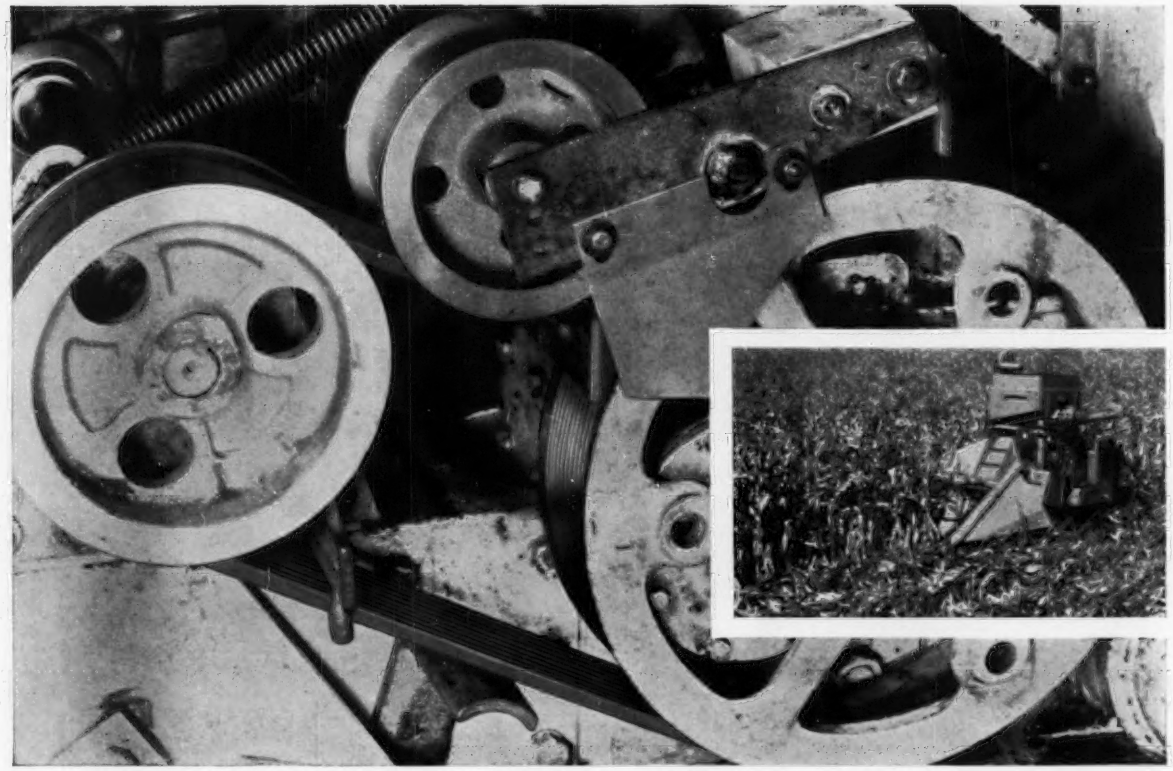

R/M Poly-V® Drive Solves Tractor Drive Problem

V-belts could snap and flat belts could slip in heavy going . . . so R/M's new patented Poly-V Drive was installed as a clutch and ground drive on this Minneapolis-Moline's Uni-Tractor. Only Poly-V Drive offered the strength and simplicity of flat belts *plus* the high V grip and positive tracking of V-belts. Result? R/M Poly-V Drive is now standard on all production units!

Equipment designers and manufacturers in every industry call Poly-V the "ideal" belt drive for solving difficult drive problems. Here's why:

R/M Poly-V Drive Saves Space — A single, endless, parallel V-ribbed belt runs on sheaves designed to mate precisely with the belt ribs. Higher horsepower capacity of this single unit belt permits narrower sheaves. Poly-V Drive can deliver up to 50% *more* power in the same space as a conventional multiple V-belt drive . . . or *equal* power in as little as ⅔ the space—with *less* shaft overhang and *less* drive weight.

R/M Poly-V Drive Runs Smoother, Cooler — No more sinking of belts in the sheave grooves: Poly-V belt speed ratio and belt position remain constant from *no* load to *full* load for uniform power delivery . . . less wear on belt and sheaves.

R/M Poly-V Drive Reduces Maintenance Costs — Drive dependability and performance is not limited to individual V-belt life. Poly-V reduces machine downtime and saves costs for belt replacement. And, because just *two* cross sections of Poly-V Belt meet *every* power transmission requirement, costly belt and sheave inventories are cut to a new low! Poly-V is also oil proof, non spark, and heat resistant.

R/M engineers who developed Poly-V* Drive are prepared to work with you to determine the installation that will best solve your present and new drive design problems. Contact your R/M representative . . . or write for Poly-V Drive Bulletin #6638.

*Poly-V is a registered Raybestos-Manhattan trademark.

RM-631

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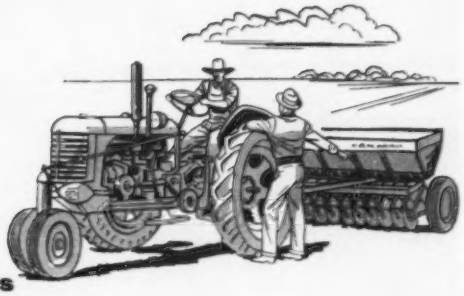
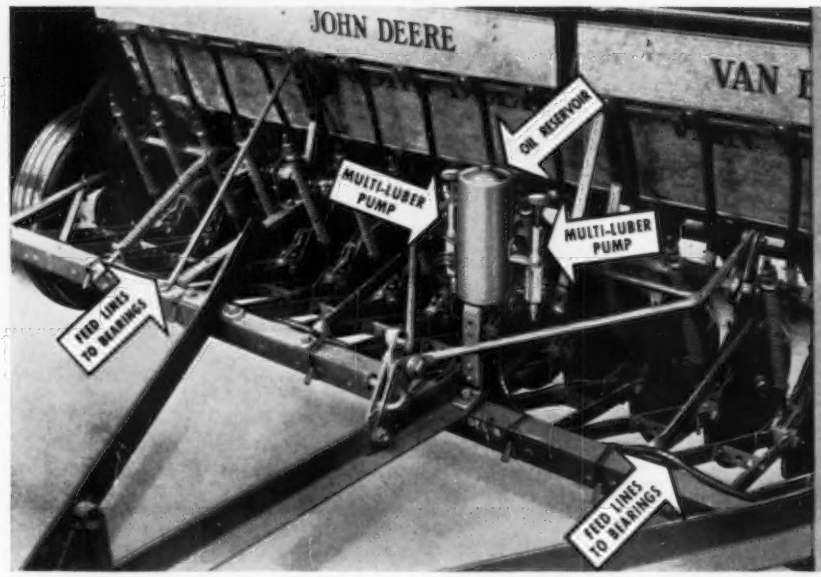
Lincoln pushbutton power lubrication for farm implements

- Eliminates oiling and greasing time in the field
- Assures more productive work per daylight hour



Assures Positive Pressure Lubrication in Seconds . . . Extends Bearing Life . . . Increases Machine Efficiency . . . Pays for Itself in One Season



Disk bearing life for John Deere Van Brunt Company Grain Drills is infinitely prolonged through metered positive pressure lubrication to each bearing. Lincoln Multi-Luber Systems save labor by eliminating need for individual lubrication of furrow openers . . . save time and trouble by using same oil as used in the tractor crankcase.

easy to use . . . simple to install . . . precision built to last!

Lincoln Multi-Luber* power lubrication system permits simultaneous lubrication of all bearings in seconds . . . on such farm equipment as corn pickers, combines, manure spreaders, mowers . . . any implement having multiple bearing points. Provides proper, frequent lubrication . . . flushes bearings as it lubricates . . . pays for itself quickly.

Either manually or power operated, the Multi-Luber System is an injector pump that dispenses measured amounts of oil from 12 outlet ports through sealed tubing, to the bearings. The net result is a sharp reduction in costly lubrication time . . . with overall improved field performance.

Write today for full details!

*Trade Name Registered

Lincoln

THE MOST TRUSTWORTHY NAME IN LUBRICATING EQUIPMENT

LINCOLN ENGINEERING COMPANY
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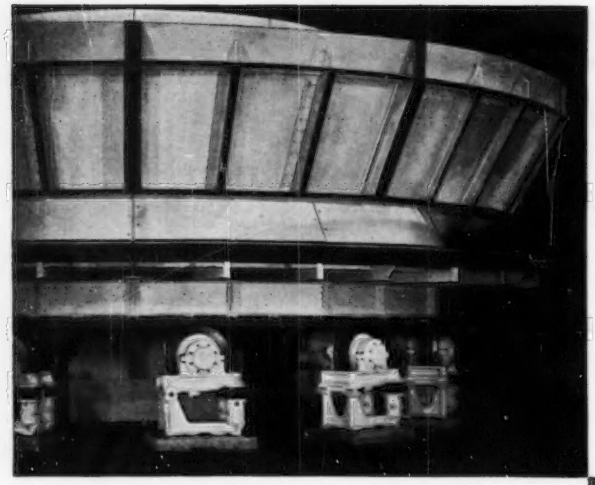

THE HEAVIER THE LOAD...

the more you need HYATTS . . . because straight cylindrical roller bearings will carry far more load, size for size, than any other anti-friction type. Here HYATTS support *one million* pounds on a 50-foot sinter cooler.

THE HIGHER THE SPEED...

the more you need HYATTS . . . because they're built from superior steels, with precise control of internal clearances to guarantee smooth trouble-free performance in critical applications like locomotive traction motors.

THE MORE YOU NEED *Cylindrical* HY-ROLL BEARINGS

Today's more compact machine designs, which must often accommodate higher speeds and loads in less space than ever before, are showing up the shortcomings of limited-capacity bearings. That's why more and more manufacturers are turning to HYATT Hy-Rolls—the straight cylindrical roller bearings that can carry *more* radial load in *less* space. Ask your nearest HYATT Sales Engineer for recommendations—he can help you solve your problems! Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.; Pittsburgh; Detroit; Chicago; and Oakland, Calif.

THE RECOGNIZED LEADER IN CYLINDRICAL BEARINGS

1908–1958 GM FORWARD FROM FIFTY

HYATT HY-ROLL BEARINGS

THE "WORKHORSES" OF MODERN INDUSTRY

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Report to Readers . . .

TWO TRACTORS DEVELOP MORE PULLING POWER IN TANDEM THAN SEPARATELY

Engineers at Ford have demonstrated, in experiments at two state colleges and elsewhere, how two four-wheel tractors combined as a single unit can be made to deliver up to 45 percent more drawbar pull in loose soil than the total combined pull of the same tractors used conventionally. . . . To produce this single unit, the front wheels of both tractors were removed, and a special linkage system was used to connect and provide a pivot point between the two units. Hydraulic cylinders anchored to the front tractor provided steering controls, with the entire front unit swiveling. Both machines were operated from the seat of the rear tractor . . . Eliminating the front wheels of both tractors did away with their rolling resistance. Also, since the rear set of drive wheels rolled in the track of the front wheels, the tractive power they delivered was considerably higher than that of the front wheels. The engineers found that the resulting gain in pull was accomplished with up to 35 percent greater power efficiency and work output for the fuel consumed. . . . Ford engineers advise that additional experiments will need to be carried out with this tandem unit before its practical possibilities can be fairly and fully evaluated. . . . The market potential for such a combination unit is of course problematical, but with the efficiency and economy which it makes possible, it will no doubt appeal to a sizable number of prospective purchasers. However, it is not so likely to appeal in cases where there would be need for rather frequent conversion from the tandem unit to two single units, and vice versa.

TAPE RECORDER TRAPNEST TAGS THE HEN THAT LAID THE EGG

Automation in the henhouse has advanced a step nearer with the development in England of a tape-recorder trapnest. This device does away with the need for an attendant to release birds from trapnests after they have laid. Each hen, whose production is to be recorded, carries a saddle on her back, and on this saddle is a roller engraved with the hen's number. After laying, the hen leaves the nest through a special trap door, and here the roller engages in a slot and, after passing over an inked pad, it imprints the hen's number on a paper tape. Records of egg production can then be made up from these imprinted paper tapes.

ENGINEERS SOLVE MAJOR PROBLEM IN PRODUCTION OF SUGAR CANE

Clearing the cane stubble after harvest has always been one of the major problems in the production of sugar cane. But now comes the announcement that engineers at the Louisiana Agricultural Experiment Station have taken a long stride toward solving this problem, in their development of a soil pulverizing machine. While not yet in commercial production, the engineers believe it can be built for about $2,000, or less than the cost of the three implements required for conventional stubble clearing – and it does a better job of soil preparation in a single operation than the conventional implements do in three. . . . This new machine consists of four revolving vertical disks, 18 inches in diameter, on each of which is mounted right-angle blades which chop the soil and stubble. Hauled behind a tractor and powered from the power take-off, the machine will pulverize a strip 20 inches wide and up to 6 inches deep, wich is sufficient to clear a row of cane stubble. It will chop the stubble into 3 to 4-inch pieces, thereby eliminating the problem of the cane growing back into the clover or other crops, and will distribute the chopped cane roots through the soil. . . . Another advantage of the machine is that it pulverizes only the rows of stubble in a cane field, leaving the area between the rows solid and firm. Then when clover is grown in the pulverized soil, cattle will graze from the solid ground and not trample the clover.

LOOKING BEYOND THE HORIZON OF ENGINEERING DEVELOPMENT

At no time in the whole history of agriculture have new engineering developments appeared in such number and variety as in the recent past. Agriculture as an industry is in a state of transition that calls for the highest order of engineering imagination and know-how. The challenge to the engineer to develop new and improved equipment and systems of operation continues to mount. In fact, he must constantly be designing new equipment and redesigning current models to provide for the use of more power and to increase the scope of their usefulness. Engineers are aware that they cannot confine their efforts to refining or improving present basic methods and equipment; they realize that they must focus more and more attention on fundamentals and thereby explore new avenues of approach for the answers that will lead to the best ultimate solutions of the many problems confronting them. . . . Present indications are that there will be a greater need than ever, in the years ahead, for attaining higher levels of efficiency and economy in all farming operations, that will be attained only with better equipment. And these levels will not remain static; they will always be some jumps ahead of the engineers. Truly the great urge of the moment is to get thinking into orbit with the new "spootneek" age.

THIS ELECTRIC FENCE PASSES CURRENT ONLY WHEN TOUCHED

An important feature of a new electric fence, developed in Britain, is that it saves electricity. Its current is supplied from a 250-volt battery through a gas-filled relay tube, and a resistance between the wire and the earth is so adjusted that the relay is just on the point of operating. When the wire is touched, a parallel resistance path is offered which lowers the total resistance to the earth and allows the relay to operate; and as long as an animal is in contact with the wire, a high-voltage impulse is applied and repeated at one-second intervals.

IMPACT OF CHEMISTRY-ENGINEERING TEAM ON ROW-CROP FARMING

Focusing attention on the general subject of the application of biological chemicals in agriculture, Dale E. Wolf of du Pont, in "Farm Chemicals" for November, directs particular attention to some revolutionary concepts that are likely to result from the impact of the chemistry-engineering team on farm production. One of these relates to row culture of crops. The author surmises that originally the reason for row culture was to provide space between plants for control of weeds, and he goes on to say that, with the progress already made in chemical weed control, the time may not be far off when crops will go through their entire growing season without the necessity of any weed control operation. . . . In such event, production might well be increased by the use of some other than the present row-crop pattern, which would involve replacing row pickers for crops like corn and cotton with the "combine" type of harvester, the development of which for corn is already making promising progress. "In the control of insects and plant diseases," Wolf writes, "we are moving more and more toward the concept of systematic protection, which is really the creation of immunity by chemicals." He looks forward to the day when seed or young plants can be treated once to obtain protection for the entire season. . . . While such a development would be a radical departure from the present-day concept, it is not likely that engineering problems in farm production would thereby be appreciably lessened. In fact, the history of at least the newer developments in this field suggests the need of more, not less, engineering, as the new replaces the old . . . Another thing, with population pressures mounting in many parts of the world, the problem of providing adequate supplies of food for all peoples – even now desperately low in some areas – appears certain to become increasingly urgent. The mechanics of easing this critical world-wide situation can best be accomplished by three-man teams of chemists, biologists, and engineers, with, of course, the proper moral and financial support of governments and peoples concerned. Actually the need is NOW.

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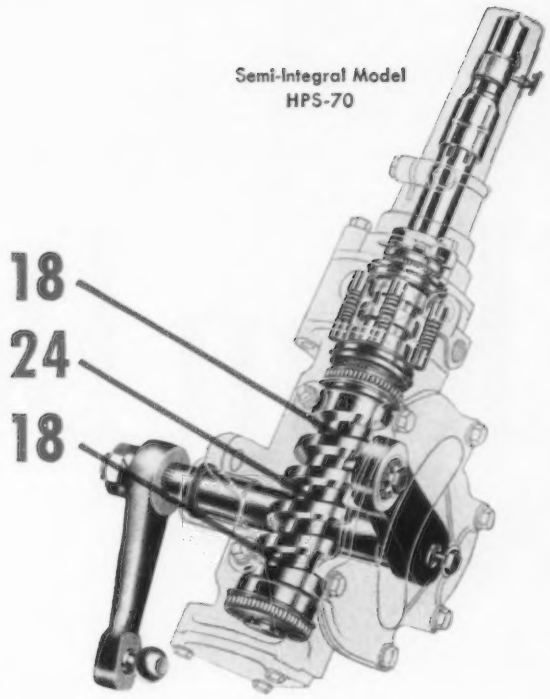

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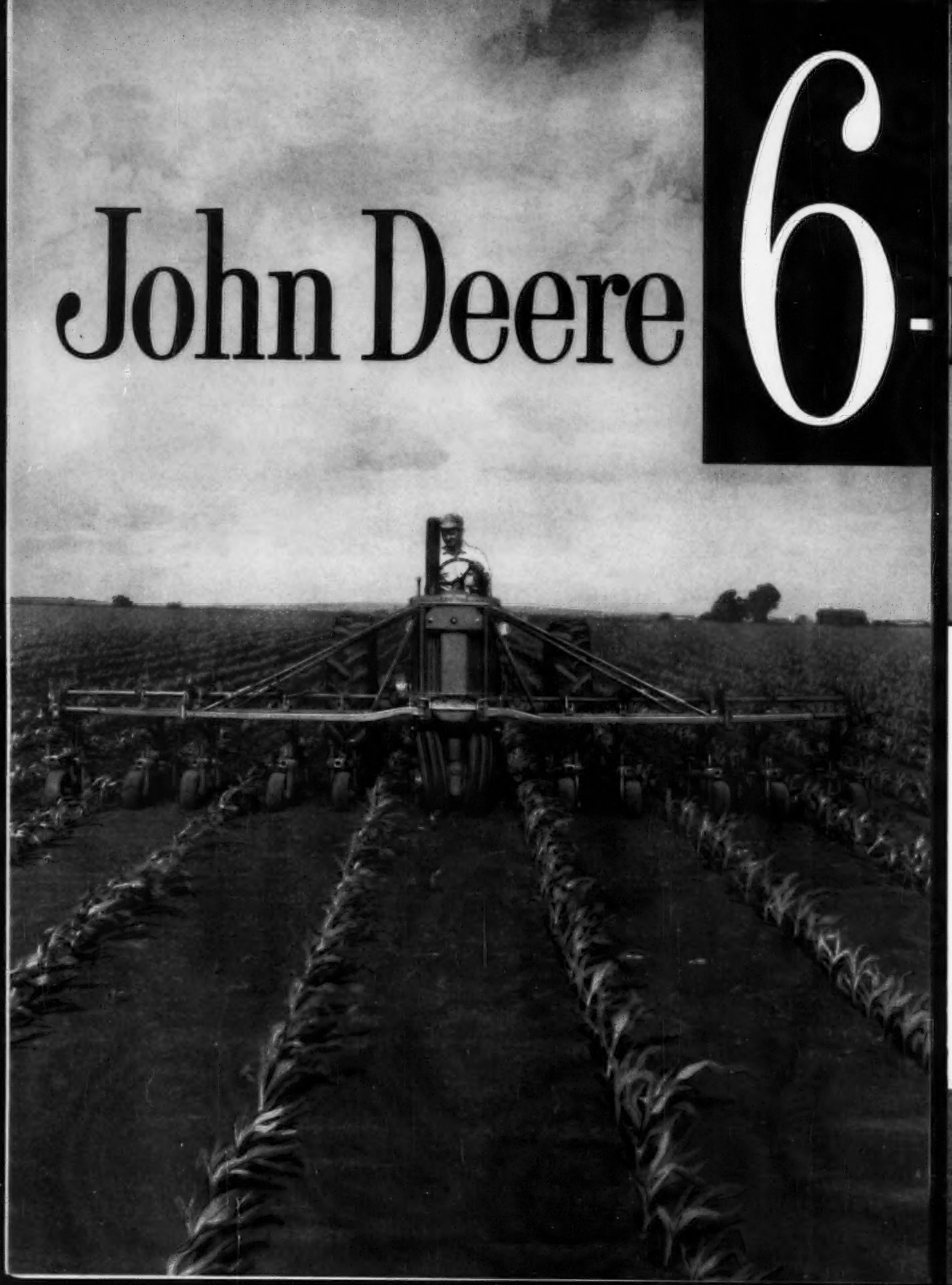

row equipment

It's blazing a wide new trail in row-crop farming

In the face of the growing scarcity of competent help, continually rising production costs, and the many other factors which each day put a premium on his time and labor, the row-crop farmer is ever on the lookout for ways to squeeze more work into every hour. And John Deere has the answer for him—modern, big-tractor power equipped with big-capacity 6-row equipment.

Blazing wide new trails in southern farming are new fully integral, quickly attached 6-row bedders and listers, as well as a new fully integral cotton and corn planter for drilling or hill-dropping on flatland, in beds, or on furrows.

For the corn belt the 6-row job is being done by a new planter which, in addition to drilling or hill-dropping is capable of accurate check-planting of corn, beans, and other seeds.

John Deere 6-row farming equipment also includes a Quik-Tatch cultivator that really spreads its wings. Outer sections can be folded forward for narrowing the transport width or removed entirely for cultivating crops planted with 4-row equipment.

Many new conveniences and outstanding features contribute to the easy maneuverability, quick adjustments, and excellent field performance of these new machines.

This is the kind of advanced engineering that makes the John Deere franchise the most valued in the industry.

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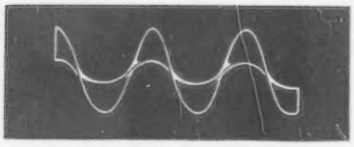

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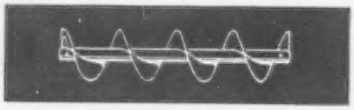

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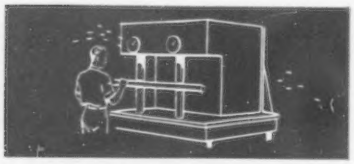

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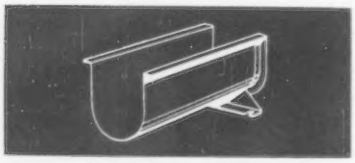

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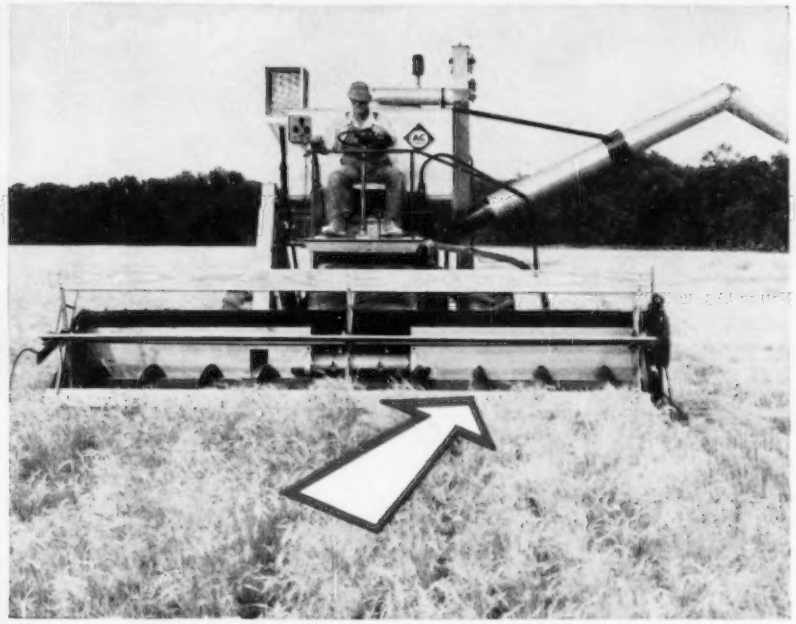

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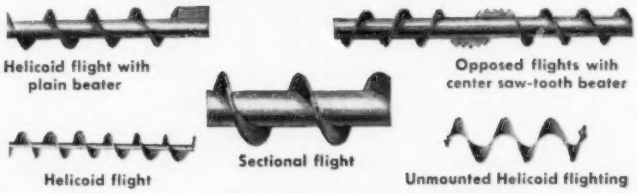

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Agricultural Engineering

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James Basselman, *Editor*

Amending the Constitution

DURING the Winter Meeting of ASAE in Chicago, December 17, a special business meeting was held for the purpose of considering amendments to the ASAE Constitution. In essence the amendments provide for selection of the president one year earlier than at present to allow him one year of service on the Council before his term as president, and the selection of one councilor for each authorized and operational professional Division of the Society.

The following sections of the Constitution will be affected by the proposed amendments:

(Substance of proposed amendments italicized)

ARTICLE C 6 THE COUNCIL (DIRECTORS)

Sec. 2 The Directors shall be the President, *President Elect*, three Vice-Presidents, *immediate surviving Past President, and one Councilor for each authorized and operational professional Division of the Society.*

Sec. 4 The Council shall meet during or immediately after the close of the Annual Meeting of the Society, at such other times as the Council may select, and at the call of the President. *Five* Directors shall constitute a quorum of the Council.

ARTICLE C 7 ELECTION OF DIRECTORS

Sec. 1 The Society shall elect annually a regular Nominating Committee, *including a representative of each Division. It shall be the duty of this Nominating Committee* to select candidates from the corporate membership for the elective offices to be filled at the next annual election, *and candidates for the new regular Nominating Committee.*

Sec. 3 An election of Directors shall be held annually, and this election shall be by sealed letter ballot of the corporate membership. *Each qualified voter shall be entitled to vote for a candidate for each elective position.*

Sec. 4 *The President Elect shall be elected for one year, at the end of which he shall automatically succeed to the office of President.* Each Vice-President shall be elected for a 3-year term and *each Councilor for a 2-year term.* The Council shall have power to fill vacancies in its membership by appointment until the *Annual Meeting following* the next election, except that in filling the office of President, the Council shall choose the Vice-President with the longest consecutive service in that office.

ARTICLE C 16 AMENDMENTS TO THE CONSTITUTION

Sec. 2 Any changes in the order or numbering of paragraphs of the Constitution, By-Laws, and Rules required by an amendment shall be made under the direction of the *interests of the Society in all cases where a change of practice directed by an amendment may best be affected over a reasonable period of time.* Council. *The Council shall direct the transition in the best*

Transition Plan

In compliance with the Constitution, the proposed amendments were presented, discussed and approved for letter ballot by those present at the business meeting. Action on the amendments will not be final until voted upon by the corporate membership of the Society by sealed letter ballot. Ballots will be mailed in the near future. Adoption of the amendments shall require a favorable vote by two-thirds of the votes cast.

Upon approval the Council of ASAE has the authority to select a satisfactory and orderly plan for the transition from the present to the new system of electing Society officers. A possible plan discussed during the Council Meeting in Chicago which will require until 1961 to complete transition, is described below.

Since the slate of officers for 1958 has been selected, no change can take place until 1959. For each year until transition to the new system is completed candidates listed on ballot and those to serve on Council are shown.

1958 (Present system)
On ballot: President, vice-president, councilor
Serve on Council (9 members):
President, 3 vice-presidents, 3 councilors, 2 past-presidents

1959
On ballot: President (on Council 1 year as past-president), president elect, vice-president and councilor (2-year term)
Serve on Council (10 members):
President, 3 vice-presidents, 3 councilors, 2 past-presidents, 1 president elect

1960
On ballot: President elect, 1 vice-president, 2 councilors (2-year term)
Serve on Council (11 members):
President, 3 vice-presidents, 2 past-presidents, 4 councilors, 1 president elect

1961 (Transition completed)
On ballot: President elect, vice-president, 3 councilors (2-year term)
Serve on Council (11 members):
President, 3 vice-presidents, 1 past-president, 5 councilors, 1 president elect

After transition is completed a total of five councilors will be elected for 2-year terms. Three will be elected one year and two during alternate years.

Penetration of Liquid Jets in Soil

S. V. Arya and G. E. Pickard
Assoc. Member ASAE Member ASAE

Study of the effect of several factors on penetration of liquid jets in soils reveals important design information for high-pressure injection equipment. Results offer an engineering approach to design problems of direct injection of anhydrous ammonia

DIRECT injection of anhydrous ammonia into the soil substitutes kinetic energy of the material itself for the traction energy normally used to pull the applicator knives through the soil. Since kinetic energy is a function of density and velocity which is produced by releasing the material under pressure, it is apparent the determination of velocity-pressure-energy-density relationships is essential to an understanding of the problem of injection. These relationships concern the jet of liquid as it leaves the orifice. It is then necessary to establish how the jet will behave as it moves through the air gap between the orifice and soil surface and how it will be acted upon by the soil particles during actual penetration.

In order to comprehend the process of injection and to set down probable requirements for satisfactory operation it is necessary to outline the factors and relationships involved in each of these phases, namely *(a)* formation of the jet (conversion of pressure energy into velocity energy by the nozzle), *(b)* movement of the jet through air and *(c)* movement of the jet through soil.

Paper prepared expressly for AGRICULTURAL ENGINEERING.

The authors — S. V. ARYA and G. E. PICKARD — are, respectively, lecturer at Indian Institute of Technology, Kharagpur, formerly graduate student at the University of Illinois; and professor, University of Illinois, Urbana.

Formation of the Jet

The formation of a jet depends upon the density and pressure of the liquid ejected and the efficiency with which the pressure is converted into velocity.

Expressions for velocity are developed in equations [1] and [2].

Symbols used in the analysis

A is a constant
a is velocity of sound in air in feet per second
C_e is the coefficient of conversion, i.e., between pressure and velocity
d is diameter in feet
$f()$ is a function
g is acceleration due to gravity in feet per second per second
H_p is pressure head in feet
H_v is velocity head in feet
KE is kinetic energy in foot-pounds
k_1, k_2, k_3, k_n are constants
M is mass in slugs
n is kinematic viscosity of the liquid in stokes
p is pressure in pounds per square inch
R is resisting force in pounds
V is volume of liquid in cubic feet
v is velocity in feet per second
w is density in pounds per cubic foot
x is distance of movement of a mass in feet

Formation of the Jet

Velocity head $H_v = C_e H_p$ but, $H_v = v^2/2g$ and $H_p = 144p/w$ so $v^2/2g = C_e 144p/w$ or $v = (288 C_e g p/w)^{1/2}$. [1]

Of these factors g is a constant and, for a single nozzle, C_e can be considered essentially constant so $v = k_1 (p/w)^{1/2}$ [2]

Energy of the Jet

The kinetic energy of a volume V of liquid having density, w, is $KE = Vw\,v^2/2g$ and substituting from equation [1] for v, $KE = 288(gwpVC_e)/2g$ $w = 144C_e\ p\ V$ . . . [3]

Movement of the Jet through Air

The loss of kinetic energy of a mass M of liquid during the short interval involved is $M/2(v'^2 - v''^2$ where v' and v'' are the initial and final velocities of the mass. The loss of kinetic energy is due to air resistance R which will be taken as constant or equal to the average resistance. If the change in velocity occurs in a distance x feet, the work done to reduce the kinetic energy is $Rx = \frac{1}{2}M(v'^2 - v''^2)$ from which

$$R = M(v'^2 - v^{2''})/2x \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [4]$$

Resistance, R depends upon velocity and diameter of the projectile and the density, viscosity and elasticity of the air. These relationships (1)* can be expressed $R = w'\ d^2 v^2 \cdot f\ (v/a.\ vd/n)$ . . . . . [5]

in which w' is the density of the air and other symbols are listed earlier. $f(v/a,\ vd/n)$ is a function called the drag coefficient.

At *low velocities*, this relationship takes the form $R = kw'\ dnv$ but since for the present study the properties of air can be considered constant $R = k_4\ dv$ . . . . . [6]

Substituting this value of R in equation [5] $k_4 dv = M(v'^2 - v''^2)/2x$

When the distance of movement of the jet is short $v = (v' + v'')/2$ so $x = M(v' + v'')\ (v' - v'')/k_5 d(v' + v'')$

or, since M is constant, $x = k_5(v' - v'')/d$ . . . [7]

and, total depth of penetration in air (when $v'' = 0$)

$$x = k_5\ v'/d \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [8]$$

At *higher velocities* below acoustic velocity, the resistance coefficient is constant (1) so $R = A'w'd^2v^2$ and $x = k_6(v' - v'')/d^2(v' + v'')$ and if the distance traveled is very small and $v'' = 0$ (for maximum penetration) $x = k_6/d^2$ . . . . [9]

Penetration of the Jet in Soil

The expressions(2) for the drag of small particles moving through a fluid are: for *low velocities* $R' = k_7 wvdn$. [10]

and for *high velocities* $R' = k_8 wd^2v^2$ . . . . . [11]

Since velocities in this study are high and the density of the liquid is considered constant the drag or resistance of the particles to penetration of the jet is $R' = k_9 d^2 v^2$ . . [12]

*Numbers in parentheses refer to the appended references.

From the relationship acknowledged in the derivation of equation [2], two conclusions are drawn:

Conclusion I Velocity of the jet varies directly as the square root of the pressure.

Conclusion II Velocity of the jet varies inversely as the square root of the density of the liquid.

Energy of the Jet—The kinetic energy of a liquid is derived in equation [3], from which the following conclusions are drawn:

Conclusion III Energy contained in a jet varies directly as the pressure.

Conclusion IV Energy contained in a jet varies directly as the volume of liquid ejected.

Conclusion V Energy contained in a jet of given volume and pressure is independent of the density of the liquid.

Movement of the Jet through Air

For purposes of analysis the movement of the solid jet of liquid emerging from an orifice during the short period prior to break-up will be considered as a projectile. The loss of kinetic energy of liquid during the short interval is calculated in equation [4].

Resistance depends upon velocity and diameter of the projectile and the density, viscosity and elasticity of the air. These relationships are expressed in equation [5]. For low velocities refer to equations [6, 7, 8]. From equation [8] other conclusions can be drawn:

Conclusion VI For the same mass of liquid, higher initial velocity will give greater penetration in air.

Conclusion VII For maximum penetration of a given mass of liquid in air a thin stream ejected for a greater length of time should be used.

For high velocities see equation [9]. Comparing equations [8] and [9] it is evident that at very high velocities it becomes increasingly important to use small orifice diameters and the effect of the initial velocity becomes less significant.

Obviously, a mass of liquid does not move through air exactly as a solid projectile. The following factors must be considered:

- Liquid masses moving at high velocity in air break up into small particles.
- Velocity of the mass is not constant. Velocity in any stream is maximum at the center and decreases toward the sides and leading face. The energy of these portions decreases rapidly.
- Turbulence inside the liquid mass results in lateral velocities which cause the mass to expand in diameter, thereby greatly increasing the air resistance and energy loss.

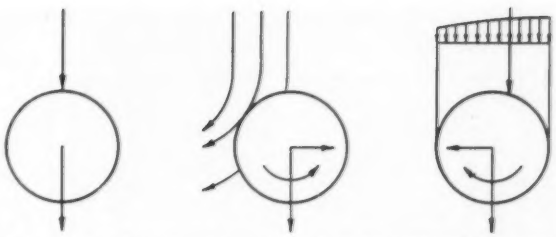

Fig. 1 *(Left)* A large soil particle tends to be displaced by a small jet acting through its center of gravity. • Fig. 2 *(Center)* A small jet striking a large soil particle eccentrically produces a tendency toward rotation combined with downward and outward motion. • Fig. 3 *(Right)* Velocity gradient across a large jet produces the same effects on a small soil particle as those described in Fig. 2 for a small jet

From these considerations:

Conclusion VIII For minimum energy loss during the air movement phase, diameter and design of the nozzle should keep the jet solid as far as possible, and

Conclusion IX The injector should be kept as close to the soil surface as possible so that the jet enters the soil before it breaks up and while its energy is near maximum.

Penetration of the Jet in Soil

For a given jet velocity its penetration into a soil will depend upon the condition of the soil and of the jet itself. The jet may be solid or diffused. The soil may be fine or coarse, loose or compacted, and may even be in a cemented condition. The behavior of the jet in each of these conditions must be considered.

When a *solid jet* strikes a *highly compacted and cemented soil* the result will be similar to that of a jet impinging on the surface of a solid material. The stream will break up and liquid particles will rebound and scatter. For penetration to occur the jet must cause downward and outward movement of the soil particles. The resistance to such movement will be related to the shear resistance of the soil

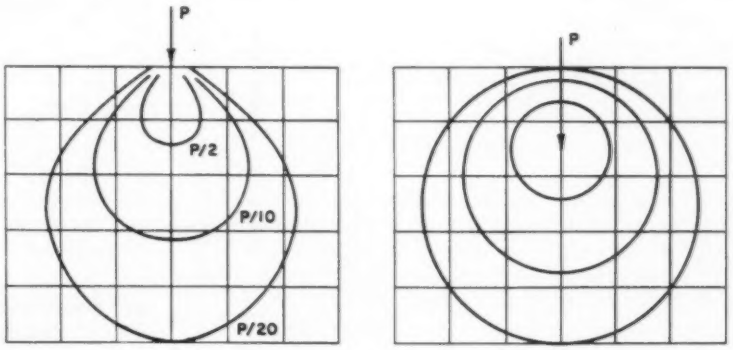

Fig. 4 *(Left)* Impingement of a jet on a soil surface develops a pressure system. • Fig. 5 *(Right)* As the jet penetrates the soil mass the point of application of pressure moves downward, changing the location and shape of the isobars

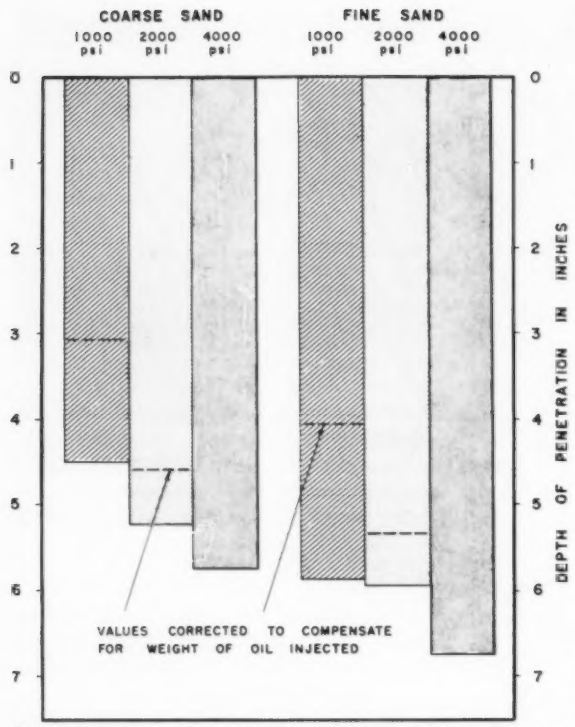

Fig. 6 Penetration of liquid jets in sand shows that increasing pressures will be an inefficient means of reaching the desired depth

. . . Liquid Penetration

which in turn is governed by the degree of compaction and cementation.

When a *solid jet* of given size and velocity strikes a *compacted, noncemented soil* surface penetration is largely dependent on *(a)* drag of the soil particles in the liquid stream, *(b)* loss of energy due to impact of liquid particles on soil particles, *(c)* turbulence created in the stream by the soil particles and *(d)* frictional resistance between the soil particles as they make way for the penetrating stream.

Considering item *(a)* a solid jet, as it strikes the surface of the soil, impinges upon many particles and we may consider the effect of one of these particles as being analagous in some respects to the movement of a solid particle through a stationary fluid. The expressions (2) for the drag of small particles moving through a fluid are shown in equations [10, 11, 12].

From equation [12] the following are drawn:

Conclusion X Resistance increases and rate of increment of depth of penetration decreases as the square of the increment in the coarseness of the soil particles.

Conclusion XI Resistance increases and the rate of increase of depth of penetration in soil decreases as the square of the velocity.

These relationships and conclusions based on drag alone hold good only if the soil particles are very fine in relation to the size of the jet. In the present study the difference in size of particles and jet is not large so loss of velocity and energy due to impact becomes important.

Movement of Particles Due to Impact

If a jet strikes a soil particle with the velocity vector of the jet passing through the center of gravity of the particle, the latter will tend to be displaced in the direction of movement of the jet (Fig. 1). On the other hand, if the jet strikes a particle eccentrically as in Fig. 2, the particle will tend to rotate and to move laterally as well as downward. If a fine particle is completely enveloped by a jet stream the same effect will develop due to velocity gradients across the stream as shown in Fig. 3. These three effects account for the "drilling" action as a jet penetrates a soil mass.

The particles so acted upon by the jet develop pressures on adjoining particles which in turn produce pressures in all directions so that a pressure system(2) as illustrated in the diagram of Fig. 4 is set up. Subsequently, as the jet penetrates the soil mass the point of application of pressure moves downward and the isobars take the shape shown in Fig. 5.

As explained for the movement of jets in air, the front of the jet decelerates most rapidly, causing a "pile-up" behind it which results in broadening of the stream. In addition, the over-all reduction in velocity causes an increase in

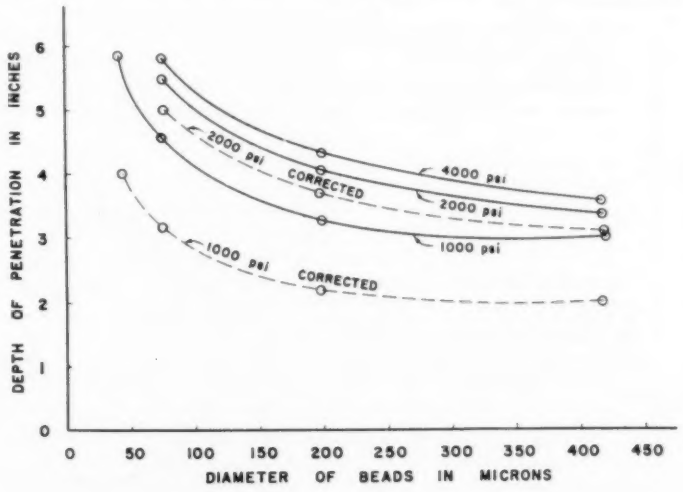

Fig. 7 Uncemented fine soil particles are more easily penetrated than are coarse particles

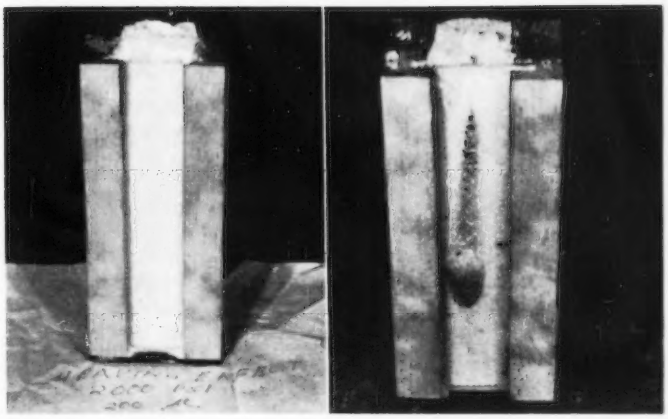

Fig. 8 *(Left)* Pressure build-up, caused by deceleration of the jet, is indicated by heaving of glass beads. • Fig. 9 *(Right)* A large proportion of the liquid injected is concentrated in the bottom of the cavity

pressure which further tends to expand the opening in the soil toward the maximum depth of penetration. It is further anticipated that with a highly volatile material like anhydrous ammonia the sudden release of pressure together with the pressure rise caused by deceleration during penetration will result in a miniature explosion which will tend to distribute the ammonia effectively near maximum depth and facilitate rapid fixation in the soil.

Solid Jet, Very Loose Soils.—These conditions permit much greater lateral and downward compaction. The jet meets relatively few soil particles which, being loosely packed, are moved downward and outward quite easily. The jet will make a clean hole and will penetrate deeply with characteristic widening toward the bottom of the hole which it bores.

Diffused Jet.—If the jet is diffused before it touches the soil surface, the fine droplets, moving at lower velocities and in divergent directions have little penetrating power. Available energy is lower; it is dissipated on a large number of soil particles; the liquid particles are relatively small compared to the soil particles so much energy will be lost in impact resulting in much blowing out of surface particles and in shallow penetration.

Experimental Procedures

Preliminary experiments were performed to explore the problems likely to be encountered in injecting anhydrous ammonia and wherever possible to verify relationships developed by the foregoing analysis. Diesel fuel was injected into graded sand and glass beads at pressures of 1,000, 2,000, and 4,000 psi. The glass beads were in sizes of 42, 75, 200, and 420 microns. The following two grades of sand were used:

Coarse—passing a No. 30 sieve, retained on a No. 50 sieve.

Fine—passing a No. 50 sieve, retained on a No. 100 sieve.

The nozzle was located at a distance of ⅞-in. above the surface of the sand and beads which were compacted uniformly by a standardized procedure. A pintle nozzle from a diesel engine was used because it has the character of producing a jet of limited diffusion.

Due to slight leakage in the injection equipment there was some reduction in the weight of oil injected at higher pressures. These quantities were 0.56 gm at 1000 psi; 0.506 gm at 2000 psi; and 0.38 gm at 4000 psi.

Results. Figs. 6 and 7 show the depth of penetration in the sand and glass beads respectively. Corrected depths of penetration are shown. These corrections were made in the ratio of weights of oil injected at the various pressures based on the weight injected at 4000 psi.

It is plainly evident that while penetration is related to pressure it is far from being directly proportional.

The shape of the curves for glass beads suggests that penetration of moderately compacted field soils which are normally much finer than the finest beads may be relatively easy. The moderate increase in penetration obtained by quadrupling the pressure suggests that satisfactory penetration under soil conditions is going to be more dependent on good nozzle design and manner of injection than on the pressure used.

Equation [3] indicated that energy of a jet is proportional to pressure so energy at 4,000 psi is four times the energy at 1,000 psi. However, equation [12] shows that drag resistance of soil particles is proportional to the square of the velocity. Velocity at 4,000 psi is twice that at 1,000 psi from equation [2], so drag resistance or energy loss at 4,000 psi is four times the energy loss at 1,000 psi. Hence the quadrupling of energy is offset by a quadrupling of energy loss. This suggests that penetration at 1,000 psi and 4,000 psi should be equal but this is taking account of drag alone.

In these studies the size of particles is large in relation to the size of the stream as compared to the conditions assumed for the derivation of the drag equation. Impact is, therefore, an important factor. High-speed movies of the jet revealed that the jets at 4,000 psi were more compact (less diffused and atomized) than those at 1,000 psi. The more solid jet produced greater drilling effect with concentrated downward energy and reduced loss of energy through impact of diffused particles on soil particles. The moderately increased penetration with increased pressure may thus be explained.

The greater penetration in fine particles can be attributed to the more favorable relationship between jet size and particle size. In large sand particles much energy is wasted in direct impact. Fine particles, on the other hand, are eroded outward from the expanding face of the jet stream as it bores its way downward. *(Continued on page 23)*

Spacing of Level Terraces in Western Iowa

W. E. Larson and F. W. Schaller

LEVEL terraces have gained in favor on the deep, permeable loess soils of western Iowa—even on steep slopes up to 18 or 20 percent. However, there has always been a great need for more information on which to base the design of these terraces.

The purpose of this paper is to report the results of two recent experiments conducted at the Western Iowa Experimental Farm and to discuss these results with respect to terrace spacings. The specific objective of one experiment was to compare the effectiveness of terraces built with different vertical intervals. In the second experiment soil and water losses were measured on small plots. The plot treatments included two crop rotations with comparisons of three seedbed preparation methods for corn in one of the rotations.

Experimental

Level terraces were established in four different fields at the Western Iowa Experimental Farm in 1946 and 1947. Land slopes in these fields range up to 18 percent but the terraces were designed for an average land slope of 12 to 14 percent. For expermental purposes the terraces in each field were installed with different spacings as follows: 1¼, 1½, 1¾ and 2 times normal. Normal or recommended terrace spacing at the time of installation was calculated from the formula vertical interval in feet $= (S+3)/2$, where S is the percent of slope. The terraces were built with a channel capacity large enough to store a maximum of approximately 2 in. of runoff. At the present time, level terraces in western Iowa are also built to store 2 in. of runoff but the vertical interval has been changed to $0.6S+2$.

The four fields have been designated as follows: Field H, terrace spacing 1¼ times normal; Field I, 1½ times normal; Field B, 1¾ times normal; and Field G, 2 times normal. The fields were farmed in a 4-year rotation of corn-oats-meadow-meadow. The rotation system was in phase by 1948. In that year Fields G, B, I, and H were, respectively, in second-year meadow, first-year meadow, oats with a meadow seeding, and corn. The corn was always loose-ground listed on the contour and the oats and meadow seeding were drilled in a seedbed prepared by disking the corn stalks. The meadow consisted of brome-alfalfa and was pastured in all years except 1956 when the first year meadow was cut for hay.

The terrace ridge back-slopes have remained in meadow in all fields except field H where the ridge back-slopes were farmed according to the rotation. In some years the field for corn was spring plowed and in some years fall plowed. The fields were plowed with a conventional one-way plow. The back-furrow was placed toward the ridge front-slope and the ridge back-slope, thus leaving the dead furrow approximately mid-way between the terraces.

The predominant soil type on the four fields is Ida silt loam; however, small areas of Monona silt loam also occur. Both of these are deep loess soils. A mechanical analysis of the surface soil of Ida silt loam from one location on the farm showed that it contained 13.8 percent sand, 61.0 percent silt and 25.2 percent clay.

In 1949 after the terraces had been established for 2 or 3 years, cross sections were located and surveyed in the following way. Three or four terraces occurred in each field. Typical locations in the field were selected, and three or four traverses were laid out at approximate right angles to the terraces, starting at the top terrace and ending at the bottom one. Bench marks for each traverse were then placed in the terrace ridge back-slope of the top and bottom terraces. In this way cross sections could be surveyed and accurate elevations marked for future reference. The original number of cross sections from the four fields varied from 8 to 12. Unfortunately many of the bench marks were removed, damaged or the location lost between 1949 and 1956. Thus in 1956 it was only possible to obtain 2, 4, 2 and 10 cross sections that could be compared with the 1949 cross sections, respectively, for fields H, I, B and G.

Soil and water loss measurements at the Western Iowa Experimental Farm were made from small 0.175-acre plots. These plots were established in 1948. Soil and water losses were recorded from all crops in a corn-oats (sweet clover catch crop) and a corn-oats-meadow-meadow rotation. In

TABLE 1. REDUCTION IN TERRACE CHANNEL CAPACITIES FROM 1949 TO 1956 AS INFLUENCED BY DISTANCE BETWEEN TERRACES

Field	Channel cross section 1949	Channel cross section 1956	Loss in cross section	Slope	Length between terraces	Vertical interval
	Square feet		percent	percent	feet	feet
	Spacing formula $2[(S+3)/2]$					
G-I-1	17.0	11.6	31.8	13.6	—	16.0*
G I-2	9.6	9.8	—2.1	13.7	128	16.2
G I-3	16.3	13.9	14.7	16.0	122	17.0
G II-1	31.5	26.6	15.5	13.1	—	16.0*
G II-2	19.5	14.3	26.8	12.5	142	15.7
G III-1	39.1	32.2	17.6	9.3	—	16.0*
G III-2	16.9	19.8	—17.2	5.2	304	16.2
G III-3	12.6	11.6	7.9	15.2	126	16.3
G IV-1	18.2	17.7	2.7	10.3	—	16.0*
G IV-2	38.6	35.0	9.3	9.8	171	16.1
Average	21.9	19.2	10.7	11.9	—	16.1
	Spacing formula $1½[(S+3)/2]$					
I II-1	17.0	14.6	14.1	8.3	—	10.5*
I III-1	7.8	7.9	—1.3	7.7	—	10.5*
I III-3	8.2	7.7	6.1	15.4	54	10.0
I III-4	5.4	4.2	22.2	14.8	68	13.0
Average	9.6	8.6	10.3	11.6	—	11.0

*Approximate interval for top terrace.

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Recent experiments on the deep loess soils of Western Iowa have led the authors to recommend changes in cropping methods to permit wider terraces

the corn-oats (sweet clover catch) rotation corn was planted in three different ways as follows: *(a)* surface planted up-and-down hill, *(b)* surface planted on the contour, and *(c)* contour listed. In each treatment the sweet clover was spring plowed prior to surface planting or listing of corn. In the corn-oats-meadow-meadow rotation the land was spring plowed and the corn contour listed. In each treatment the oats were broadcast and disked into the corn stubble. The sweet clover and meadow seedings were made by broadcasting the seed after disking in the oats. Because of the small size of the plots all of the above tillage operations were done by hand to simulate field conditions.

The plots are 10.5 ft wide by 72.6 ft long. The soil type is Ida silt loam with a 12-percent slope. Soil and water loss from each plot was collected in two metal tanks separated by a 5-slot Geib divisor.

Results

Terrace channel-capacities in 1949 as compared to those in 1956 are given in Table 1. The percent reduction in channel cross sections for 2 × normal and 1½ × normal spacing was 10.7 and 10.3, respectively. The standard error of the mean for the former was 3.9 and for the latter 14.4 percent. Thus in both cases the reductions in channel cross sections are small and indicate no substantial soil movement between terraces or silting in terrace channels. This trend was also evident from the observations made in the other two fields. A typical cross section taken in 1949 and 1956, from each of the four fields with different terrace spacings, is given in Fig. 1. This diagram not only illustrates the change in cross sections for the period of study but also shows generally the capacities and design characteristics of the terraces.

While no exact measurements of depth of water in the terrace channels were made, observations following storms have shown no overtopping of the properly constructed terraces. In a few cases, low spots in the terrace ridges allowed water to overtop during the first few years of the experiment. These were repaired, and since that time no water has been lost from any of the fields.

TABLE 2. ANNUAL RAINFALL AT THE WESTERN IOWA EXPERIMENTAL FARM NEAR CASTANA FOR THE PERIOD 1949 TO 1956

Year	Annual Precipitation
1949	22.03
1950	28.31
1951	42.85
1952	30.57
1953	23.80
1954	33.79
1955	16.63
1956	21.59
Normal*	24.90

*Official weather bureau normal (For 1921-1950) at Sioux City Airport.

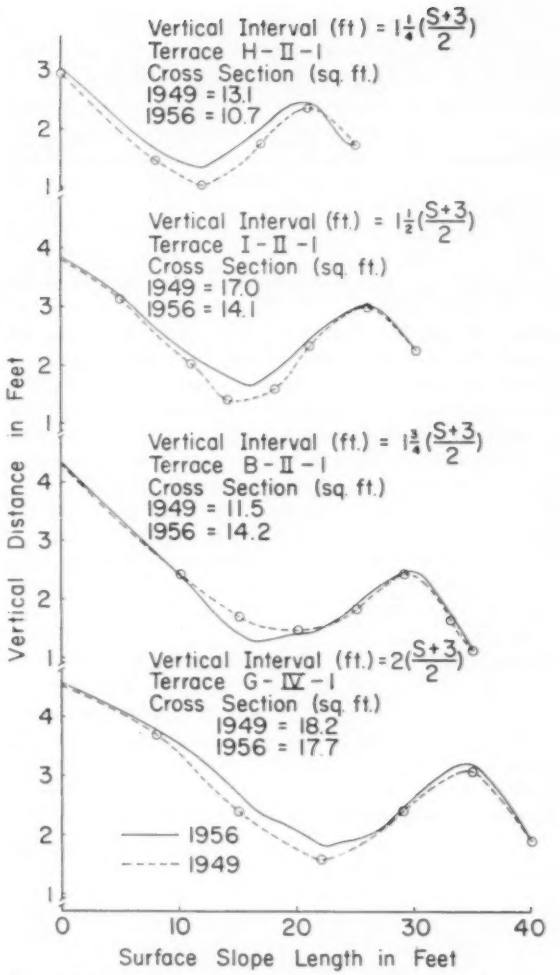

Fig. 1 Typical cross sections taken in 1949 and 1956 from four terraces with different spacings

Rainfall above and below normal has occurred during the period of this study (Table 2). However, since runoff and erosion are not closely related to annual precipitation, a study of some of the more intense storms has been made. A summary of total rainfall, rainfall intensities, and ante-

TABLE 3. TOTAL AND INTENSITIES OF RAINFALL FOR THE TWELVE 24-HOUR PERIODS CAUSING THE MOST RUNOFF AND EROSION ON THE RUNOFF PLOTS

Date	Duration	Total rainfall	API*	Maximum Intensities			
				5 min	15 min	30 min	60 min
	hr. min	In.		In. per hour			
7-25-48	1 - 20	1.97	0	3.96	3.28	1.76	1.39
7-29 48	6 - 25	2.07	0.81	4.08	3.20	2.40	1.28
8-10-48	3 - 28	1.90	0.60	4.20	2.76	1.66	1.21
8-26-27-48	15 - 38	1.51	0	0.96	0.48	0.34	0.18
6-15-50	0 - 20	0.97	0.76	6.58	3.88	1.94	0.97
6-17-51	3 - 50	3.11	0	4.95	4.69	3.88	2.84
7-2-3-51	2 - 05	0.89	0.43	3.60	2.76	1.52	0.77
7-6-52	18 - 55	2.95	0.37	2.46	2.16	1.64	1.56
6-19-54	1 - 0	1.68	0.14	4.41	——	——	——
6-21-54	5 - 20	1.91	1.24	4.38	2.06	1.42	0.83
5-10-56	20 - 2	1.73	0	3.48	2.44	1.24	0.68
7-11-56	3 - 49	2.06	0.43	4.14	3.60	2.50	1.46

*Antecedent Precipitation Index $= \Sigma_{i=1}^{7} (0.8)^i I_i$ where I_i is the total rainfall on the i-th day of the antecedent period.

. . . Spacing Terraces

TABLE 4. MAXIMUM AMOUNTS AND RATES OF RAINFALL TO BE EXPECTED ONCE IN THE TIME STATED AT SIOUX CITY, IOWA*

Years	Maximum intensities			
	5 min	15 min	30 min	60 min
	Inches per hour			
5	6.0	4.1	2.9	1.9
10	7.0	4.8	3.4	2.2
25	8.0	5.6	4.1	2.5
50	9.0	6.2	4.6	2.9

*Estimated from U.S. Department of Commerce, Weather Bureau Technical Paper No. 25, December, 1955.

cedent precipitation indices for the twelve 24-hr periods causing the most runoff and erosion from the runoff plots during the eight years of study is given in Table 3. The maximum amounts and intensities of rainfall to be expected at Sioux City, Iowa, once in 5, 10, 25 and 50 years is given for comparison in Table 4.* Sioux City is about 50 miles distant from the site of these experiments. In only two of the 12 storms analyzed was total rainfall as much as 3 in. and in four of the storms total rainfall was from 1.9 to 2.1 in. The 60-min intensity of the storm occurring on June 17, 1951, was 2.84 in. per hour. This corresponds closely with the 2.9 in. per hour expected once in every 50 years at Sioux City, Iowa. The field with 1½ × normal terrace spacing was in corn at the time of this storm. The remainder of the storms had a 60-min intensity which would be expected with a frequency of at least once every two years.

The storms listed in Table 3 do not include the 12 largest storms but rather are 24-hr periods that caused most runoff and erosion from the runoff plots. A number of other storms with greater total amounts and intensities than some of those listed in Table 3 occurred but did not produce large amounts of runoff and erosion. The first four storms listed in Table 3 occurred before the original cross sections of the terraces were made but after the runoff measurements were started.

The antecedent precipitation index, API, was calculated for each of the 10 intense storms. The API is calculated from the rainfall occurring during the seven days previous to the storm and is used as an estimation of the wetness of the soil at the time the storm under study occurred. API's of over 1 are not common in this area and API's of 0 indicate that no rain fell during the previous seven days. The data in Table 3 show that only one of the 10 storms occurred when the API was greater than 1. The intense storm of June 17, 1951, followed nine days without rain.

Since no quantitative measurements of water losses were made from the terracing experiment, it is of interest to examine the amounts of runoff water from the small plot study. Soil and water loss from the 12 most erosive 24-hr periods are given in Table 5. These results make a comparison between tillage and cropping practices possible. In general the length and degree of slopes in both the terracing and small plot experiments were comparable.

The largest amount of runoff in any 24-hr period from corn contour listed in a corn-oats-meadow-meadow rotation was 0.48 in. Only 0.35 in. was lost from the intense storm of June 17, 1951. Runoff has not exceeded 0.88 in. in any 24-hr period where corn was contour listed in a corn-oats (sweet clover catch) rotation. In general water loss from contour surface planted corn was greater than from contour listed corn in the corn-oats (sweet clover catch) rotation. The largest loss from contour surface planted corn was 1.58 in.

The largest water loss from oats was 1.48 and 0.89 in. Runoff from meadow has been small.

Soil loss from corn contour listed in both rotations exceeded 2.2 tons per acre only once during the 12 most erosive storms. However, erosion was severe during the storm of June 17, 1951 (18.5 tons per acre) from contour

*U. S. Department of Commerce, Weather Bureau Technical Paper No. 25. December, 1955.

TABLE 5. SOIL AND WATER LOSS AS INFLUENCED BY CROPPING AND TILLAGE PRACTICES ON IDA SILT LOAM FROM THE TWELVE MOST EROSIVE 24-HOUR PERIODS, 1948 TO 1956, INCLUSIVE

Date	Corn-Oats (Sweet Clover)				Corn-Oats-Meadow-Meadow			
	Corn			Oats	Corn	Oats	Meadow	
	Contour listed	Contour surface planted	Up-and-down hill	Disked	Contour listed	Disked	First year	Second year
	Water loss, inches							
7-25-48	0.37	0.46	0.36	0.33	0.29	0.24	0.34	0.31
7-29-48	0.31	0.36	0.57	0.16	0.24	0.13	0.19	0.08
8-10-48	0.74	0.70	0.86	0.30	0.48	0.25	0.27	0.18
8-26 & 27-48	0.68	0.43	0.72	0.13	0.46	0.15	0.10	0.04
6-15-50	0.02	0.36	0.68	0.42	0.39	0.03	0.03	0.52
6-17-51	0.88	1.58	1.58	1.48	0.35	0.44	0.09	0.51
7-2 & 3-51	0.16	0.27	0.45	0.23	0.14	0.05	0.08	0.24
7-6-52	0.64	0.96	1.01	0.23	0.11	0	0	0
6-19-54	0.37	0.88	0.74	0.87	0.11	0.89	0.10	0.04
6-21-54	0.39	0.83	0.49	0.77	0.13	0.59	0	0
5-10-56	0	0.45	0.41	0.39	0	0.47	0.20	0
7-12-56	0.48	0.43	0.43	0.48	0.33	0.43	0.42	0.07
	Soil loss, tons per acre							
7-25-48	2.1	1.8	13.2	0.1	0.8	0.1	0.1	0
7-29-48	1.5	1.3	7.7	0	0.7	0.1	0	0
8-10-48	2.2	2.0	6.8	0.1	0.8	0.1	0	0
8-26 & 27-48	1.9	1.7	8.7	0	1.0	0	0	0
6-15-50	0.1	2.3	11.0	0.2	0.1	0.3	0.3	0
6-17-51	1.4	18.5	17.8	1.4	0.7	0.5	0	0
7-2 & 3-51	1.0	1.9	7.7	0.1	1.1	0	0.1	0.1
7-6-52	1.4	1.8	14.1	0.2	0.9	0	0	0
6-19-54	0.8	6.9	17.7	0.6	0.4	0.9	0	0
6-21-54	0.5	6.9	6.0	0.2	0.1	0.4	0	0
5-10-56	0	5.9	9.1	4.9	0	7.8	0.1	0
7-12-56	5.8	6.3	6.6	3.0	2.6	3.4	0.1	0.1

TABLE 6. ANNUAL SOIL AND WATER LOSSES AS INFLUENCED BY CROPPING AND TILLAGE PRACTICES ON IDA SILT LOAM FROM 1948 TO 1956, INCLUSIVE

Year	Corn-Oats (Sweet Clover) Rotation				Corn-Oats-Meadow-Meadow Rotation			
	Corn			Oats	Corn	Oats	Meadow	
	Contour listed	Contour surface planted	Up-and-down hill	Disked	Contour listed	Disked	First year	Second year
	Water loss, inches							
1948	2.34	2.27	3.04	0.92	1.72	0.79	0.90	0.61
1949	1.01	1.08	2.51	1.69	0.87	1.89	1.21	0.87
1950	0.14	2.34	5.18	3.53	0.34	2.95	2.15	0.08
1951	3.90	6.42	6.97	5.13	1.58	1.01	0.45	1.80
1952	0.88	1.18	2.42	0.63	0.12	0	0	0.17
1953	0	0.26	0.45	0.42	0	0.22	0	0
1954	0.85	1.86	3.71	2.70	0.33	2.81	0.18	0.04
1955	0.36	0.03	1.01	0.74	0.12	0.53	0.03	0.02
1956	0.48	0.95	1.58	1.77	0.33	1.38	0.71	0.07
Av.	1.11	1.82	2.99	1.95	0.60	1.29	0.63	0.41
	Soil loss, tons per acre							
1948	8.1	7.2	38.3	0.2	3.8	0.4	0.2	0.1
1949	0.1	0	6.0	0.8	0.1	0.5	0	0.1
1950	0.4	9.7	30.6	4.6	0.5	3.2	1.4	0
1951	5.7	33.5	45.9	5.0	3.7	1.4	0.4	0.1
1952	2.6	3.8	31.3	0.6	1.0	0.7	0	0
1953	0	0.4	1.8	0.6	0	0.6	0	0
1954	1.4	14.2	28.8	4.2	0.7	7.2	0.1	0
1955	0.8	0	4.1	1.0	0.2	0.7	0	0
1956	5.8	11.8	16.6	8.5	2.6	11.6	0.2	0.1
Av.	2.8	8.9	22.6	2.8	1.4	2.9	0.2	0

surface planted corn in the corn-oats (sweet clover) rotation. Erosion from oats and meadow generally has been small. The comparatively large losses in 1956 from oats and contour listed corn was accounted for by the small amount of crop cover during the severe drought.

The annual soil and water losses from the runoff plots as influenced by cropping and tillage practices are given in Table 6. From a terracing viewpoint annual water losses are of less interest than water losses from a single storm or for a 24-hr period. However, annual soil losses are of great interest since these losses are an indication of how rapidly silting may occur in the terrace channels. With the exception of 1951 and 1956, annual soil losses from both rotations have been well below permissible limits (5 tons per acre per year) when the corn was contour listed. However, in the corn-oats (sweet clover catch) rotation, erosion for the rotation was above the allowable limits set for this soil in three of the eight years when the corn was contour surface planted.

Summary and Conclusions

Level terraces with different spacings were compared at the Western Iowa Experimental Farm from 1949 to 1956. The spacings used were 1¼, 1½, 1¾ and 2 times normal. The experiment was located on Ida and Monona silt loam soil with an average land slope of 12 to 14 percent. The fields were farmed in a 4-year rotation of corn-oats-meadow-meadow. The corn was always contour listed after plowing.

It was found that under the 1½ and 2 times normal spacing terrace channel capacities decreased about 10 percent during the eight years of study. Similar results were observed on the other terraced fields in the experiment. Terrace overtopping during storms and runoff from the terraced fields was neglible.

An analysis of the 12 highest erosion producing storms showed that one storm had a 60-min intensity of 2.84 in. per hour. A storm of this intensity would be expected once in 50 years. The remaining 11 storms had 60-min intensities ranging from 0.77 to 1.56 in. per hour. These would be expected to occur at least once every two years.

Measurements of runoff and soil loss were made on small plots at the Western Iowa Experimental Farm. The soils and slopes were similar to those in the fields used for the terrace study. Soil and water losses were obtained from all crops grown in two different rotation systems and from three different tillage systems under one of the rotations corn-oats (sweet clover catch).

Results from the plot studies showed that soil and water losses from corn were considerably lower under contour listing than under contour surface planting or up-and-down hill planting. Runoff never exceeded 0.88 in. in any 24-hr period during the nine years of study where corn was contour listed. The largest loss from contour surface planted corn was 1.58 in. Soil losses in tons per acre per year during the 9-year period averaged 2.8 for contour listed corn, 8.9 for contour surface planted corn and 22.6 for corn planted up and down hill.

It is concluded from these studies that level terraces in western Iowa may be spaced wider than currently recommended provided the corn is contour listed. Furthermore, it appears that rotations with a greater percentage of corn than a corn-oats-meadow-meadow rotation can be used on slopes up to at least 12 percent if the corn is contour listed.

. . . Liquid Penetration

(Continued from page 19)

Equation [12] indicates that resistance is proportional to the square of the diameter of the soil particles. This suggests that the drag resistance of the 420-micron particles should be 100 times the drag of the 42-micron particles. However, this equation relates to a particle suspended in a stream of unlimited size. In the area attacked by the jet there will theoretically be 100 times as many 42-micron particles as 420-micron particles so the drag resistance should remain equal for the two sizes of particles. This explains the discrepancy between equation [12] and the experimental results.

Observations. The theory of increasing pressures within the sand mass with decreasing velocity of the jet stream was born out by heaving of the glass beads after injection as shown in Fig. 8. The appearance of diagonal shear planes in larger volumes of sand bore out the theory of the pressure patterns of Fig. 5.

The pattern of fuel oil deposit in the sand and glass beads is most desirable from the standpoint of reducing loss of ammonia. As shown in Fig. 9 a high percentage of the oil is concentrated near the point of maximum penetration. The face of the jet bores the hole through which the body of material flows quite freely to "pile up" in the bottom when expansion of the face builds up resistance to the point where it fails to advance. The volatility of anhydrous ammonia will produce much larger pressures at the point of accumulation which will result in maximum dispersion.

Conclusions

The purpose of this preliminary research was to study the effect of certain factors on the depth of penetration of liquid jets in soils with a view to indicating the direction in which the work of design should proceed in developing successful and efficient high-pressure ammonia injecting equipment. Results obtained from the experiments refer to the penetration of oil in a loose granular mass so cannot exactly predict the behavior of ammonia injection in field soils. However, the following broad qualitative conclusions can be drawn:

- Extreme pressures will be an inefficient method of securing penetration. Good nozzle design and use of thinner and the most solid jets possible will be most effective in securing penetration.
- Injectors should be placed as close to the soil surface as possible.
- Penetration in non-cemented, fine-textured soils should be feasible.
- Maximum penetration with minimum pressures may be achieved by concentrating the applied energy through intermittent injection rather than using continuous line injection.
- The pattern of distribution of anhydrous ammonia in the soil will favor its retention and rapid fixation.

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Molds Impose Limitations i

N. C. Teter and C. W. Roane
Member ASAE

MATERIAL contained in this article is presented for consideration in the development of statistically and economically sound practices in use of unheated air in drying of grain and is not to be regarded as design information. Although the conclusions reached are considered sound for the Tidewater Virginia region, variations of microflora and corn conditions may result in regional differences. Drying tests at the Tidewater Research Station, Holland, Virginia, in 1954 and 1955, leading to the proposed theory of ventilation, consisted of air flows of 1 cfm per bu to 36 cfm per bu in 1954 on corn having an initial moisture content of 24.2 percent and with flows of 3.8 to 19.7 cfm per bu in 1955 on corn ranging from 29.1 to 30.2 percent initial moisture content.

In 1954, air flow delivery of between 9 and 18 cfm per bu was dictated for production of No. 2 corn as indicated by visible mold development (Table 1). By interpolation, 12 cfm per bu appeared as the minimum acceptable ventilation rate. Corn was reduced to 15.5 percent moisture in about 8 days at a grain temperature averaging 73 F to produce satisfactory drying without excessive visible mold damage.

In 1955 corn coming from the field showed 16 percent initial damage resulting from the weathering of three hurricanes. The mold damage was already greater than allowed for No. 2 corn.

After completion of drying tests, corn from each rate of air delivery was sealed in a pint fruit jar and placed in a deep freeze until mold counts could be made according to Christensen's (2)* methods. Over 99 percent of the molds identified by this method were *Aspergillus flavus, Fusarium moniliforme, Penicillium* spp. and *Oospora* sp. with counts in 1954 ranging from a maximum of 406,750 colonies per gram of meal to a minimum of 2,320 for bins having unheated air.

If shelled corn has few fragments or cracked kernels it will resist mold attack more readily than badly cracked corn. Corn shelled for experimental work in 1954 consisted of 6.3 percent fragments and cracked kernels by weight when shelled at 24.2 percent moisture. These damages are comparable to those reported by Hopkins and Pickard (4) and Morrison (5) with both old and new type shellers. A comparison of molding of cracked kernels and fragments with molding of whole kernels is shown in Table 1. It is apparent from these data that cracked kernels are more subject to molding than sound kernels and that drying limitations imposed by mold growth are more stringent for damaged kernels.

The authors — N. C. TETER and C. W. ROANE — are, respectively, agricultural engineer, farm buildings section, AERD, USDA, Tidewater Research Station, Holland, Va., and associate plant pathologist, Agricultural Experiment Station, Blacksburg, Va.

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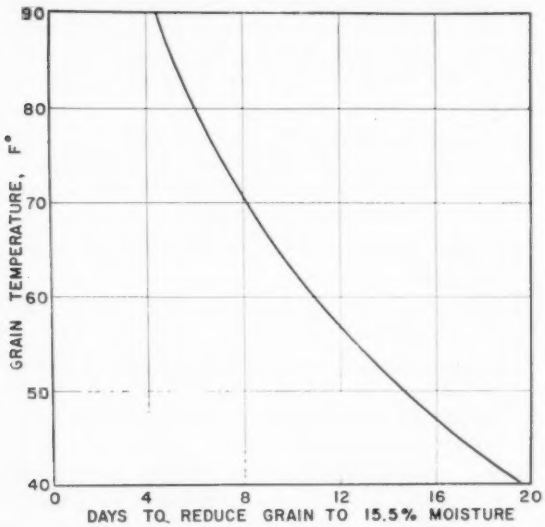

Fig. 1 A time-temperature limitation curve for reducing moisture content of grain to 15.5 percent without allowing excessive visible damage by molds. This curve is from fragmentary data. When more specific and accurate estimates are made it may be revised and extended to include the effects of variable initial moisture contents and the effect of kernel damage

TABLE 1. Visibly molded corn removed from test bins continuously ventilated with unheated air in 1954 at Holland, Va.

1954 Initial moisture 24.2 percent, mold 0.6 percent		
	Percent molded by weight	
Air flow cfm per bu	Whole kernel	Cracked kernel
36.0	1.2	0
18.0	0.6	0
9.0	5.9	39.8
6.0	5.9	47.7
3.0	13.0	52.9
1.5	14.2	60.8

Reference to cracked kernels in Table 1 refers to fragments and kernels having visible rupture of the seed coat even though some of the kernels would ride a No. 12 sieve (1⅜4-in. round holes).

Time - Temperature Limitations

Optimum temperatures for growth of *Aspergillus flavus, Fusarium moniliforme,* and *Penicillium* spp., the most prevalent molds encountered in shelled corn undergoing bulk bin drying in the Tidewater Region of Virginia, range from 78 to 98 F according to Semeniuk (7) and Ullstrup (11). Growth at 40 F is quite slow. A minimum relative humidity of 80 percent in the bulk bins is required for continued growth of these molds (7). According to Thompson and Shedd (10), 80 percent relative humidity corresponds to the equilibrium of shelled corn at about 15.5

*Numbers in parentheses refer to the appended references.

in Grain Drying

A method for estimating volume requirements of unheated air is proposed for producing No. 2 commercial grade grain, with particular reference to shelled corn

percent moisture content, wet basis. Foster (3) uses time in days required to dry grain to 15.5 percent as one criterion in comparing drying conditions to grain deterioration index. He found shelled corn dried satisfactorily when it was lowered to 15.5 percent in 18 to 27 days in temperature ranges of 34 to 46 F with continuous ventilation. For wheat, dried at temperatures of 74 to 78 F, he found a time limitation of 5 to 14 days, and that the drying time accounted for most of the variation in grain deterioration. Sorenson, Kline, and Redlinger (8) noted mold development in grain sorghum at the end of 7 days at 78 F.

A pattern of time limitation for lowering any grain to 15.5 percent moisture content appears to be dictated by mold growth. When ample moisture is present, grain temperature is the limiting factor for mold growth. A time-temperature limitation curve for reducing moisture content of grain to 15.5 percent without allowing unacceptable visible damage by molds is proposed and presented in Fig. 1. More specific points must be established before this curve is established as fact. Grain drying below 15.5 percent is largely a problem of aeration since mold growth is greatly retarded below this level. No implication is made that grain will store safely at 15.5 percent moisture content. Storage of shelled corn without aeration above 11 percent is not recommended at Holland, Virginia.

Terry (9) proposed a time limitation curve plotted against temperature for drying high moisture hay without encountering visible molds. It appears that requirements for grain drying are less stringent than those for wet hay. Presumably the curve presented in Fig. 1 would have an upper portion similar to Terry's curve if projected through higher temperatures.

Heat Use of Drying Air

When the initial moisture content of grain, the time limitation for reduction to 15.5 percent and the probable range of drying conditions are known, the approximate minimum rate of ventilation can be computed by balancing the available heat input of drying air with the latent heat of vaporization. Although, in practice, heat loss or gain from drying bins and heat of respiration cause some variation from adiabatic conditions, these variations are not serious in production of good quality dried corn. Heat gains are more commonly observed than heat losses. The wet-bulb

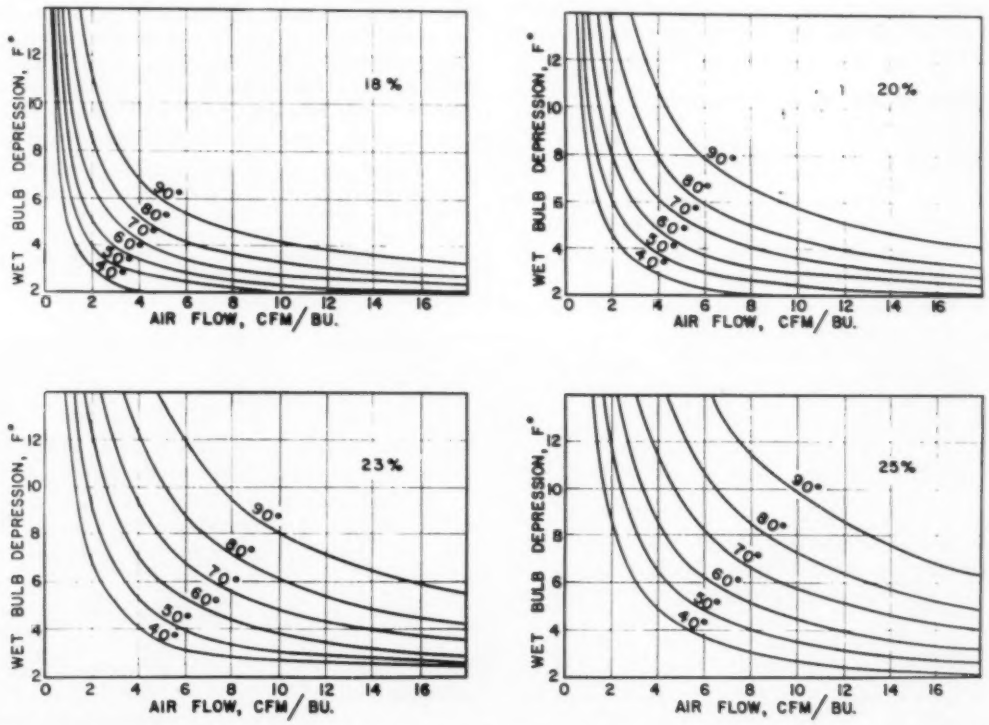

Fig. 2 Calculated ventilation requirement for drying shelled corn at four initial moisture contents and six different grain temperatures

. . . Molds in Drying

depression of air is proportional to potential drying if saturated air can be discharged from the bin. However, it is impossible to discharge saturated air as the moisture content of grain lowers from 24.0 to 15.5 percent.

The data of Thompson and Shedd (10) indicate that at 15.5 percent the discharge air cannot show less than the following wet-bulb depressions:

Temperature, degrees F	Wet bulb depression, degrees F
40	2.5
50	3.0
60	3.4
70	3.8
80	4.1
90	4.8

At the start of drying corn with 24 percent moisture content, the heat available in the wet-bulb depression of the drying air can be utilized, but heat in the portions of the wet-bulb depression indicated in the above table are unavailable to corn at 15.5 percent moisture content. The portions which are unavailable between the start of drying and the 15.5 percent point are not definitely determined, and vary with the conditions of air, grain, and depth units of grain as defined by Hukill (5). An assumption of straight line variation of the temperature depression of air through the bin from start to finish gives an average value of temperature depression of about 90 percent of that found by computing the temperature depression at various intervals along a drying curve for four depth units, the maximum for thermal efficiency (5). Since conditions are based on estimates of the future which may be more than 10 percent in error, the straight arithmetic mean, being on the side of design safety, may be used for simplicity of calculation.†

Computation of Air Volume Required

The heat balance equation between heat supplied from the drying air and the heat used in drying is:

$$0.24\,QDT = WH$$

Q = pounds of dry air per minute per bushel

D = average temperature depression through the bin, degrees F

T = allowable minutes to dry to 15.5 percent to prevent excessive mold growth

W = pounds of water to be removed to reduce one bushel to 15.5 percent moisture

H = latent heat of vaporization, Btu per lb of water

0.24 = specific heat of air at constant pressure, Btu per lb.

Latent heat of vaporization for corn may be estimated at 1100 Btu per lb of water without making adjustments for temperature and moisture variation, since the wet-bulb depressions and temperatures will necessarily be considered estimates of the probable conditions.

If a 56-lb bushel of corn at 15.5 percent moisture content is taken as a standard unit for which the ventilation is to be calculated, pounds of water to be removed may be computed readily, and the equation can be solved for air required.

Example: Corn coming in at 25 percent moisture content is to be dried with unheated air at 60 F and a relative humidity of 60 percent. What rate of air delivery is needed?

Initial depression of temperature through the bin	7.6 F.
Depression of temperature through the bin at 15.5 percent moisture content on top (7.6–3.4)	4.2 F.
Average depression	5.9 F.
Allowable days to dry to 15.5 percent moisture content from Fig. 1 based on 52 F wet-bulb temperature as approximate grain temperature	13.8 days
Water to be removed to reduce 1 bu to 15.5 percent moisture content	7.2 lb

$$(0.24)\,Q\,(5.9)\quad (13.8)(60)(24) = (7.2)(1100)$$

Q = 0.281 lb of dry air per min, or since the specific volume is 13.3 cu ft per lb of dry air, a delivery of 3.7 cfm per bu.

Fig. 2 illustrates estimates of required air delivery for drying corn based on the outlined computations.

Estimation of Weather

Any computation as described must by necessity be based upon estimates of the most probable frequency of occurrence of extreme conditions. In analyzing weather data not only the means should be considered, but also the probability data for maxima, minima and longevity of unfavorable conditions. At the Norfolk, Virginia airport the 10-year average wet-bulb depression in September, the corn harvesting month, is 5.18 F and the temperature, 72.3 F. These two figures alone would give data for entering the proposed curves for estimating the proper ventilation. However, average conditions are of little interest to a farmer who has grain molding under conditions which are worse than average. In the 10-year period studied at Norfolk, consecutive days showing wet-bulb depressions continuously below 4 F occurred at the following frequency:

Consecutive days	Number of occurrences
2	11
3	4
4	4
5	0
6	1
7	2

From these data, a logical design figure of 4 F wet-bulb depression is indicated rather than the 5.18 degree average.

The grain temperature will approach wet-bulb temperature of the air, so design temperature could be taken at about 68 F leading to a recommended unheated air flow for drying of shelled corn at Holland, Virginia of 16 cfm per bu at 25 percent initial moisture content, 12 cfm per bu at 23 percent, 7 cfm per bu at 20 percent, and 3.5 cfm per bu at 18 percent.

Summary

Climatic conditions in southeastern United States favor mold development on corn during the drying period. In

†At initial moistures below 23 percent the full wet-bulb depression cannot be used even at the start of drying. For example, the equilibrium relative humidity of 20 percent grain is about 90 percent, which means an initial loss in wet-bulb temperature depression of 1.5 to 2.5 degrees. With high atmospheric humidities this may affect the computation greatly, particularly for grain at relatively low moisture content.

shelled corn, molds dictate a time limitation for lowering the moisture content to a relatively safe 15.5 percent. A time-temperature limitation curve for drying shelled corn to 15.5 percent moisture content is presented. Using this curve and other readily obtained data the heat balance equation $0.24\ QDT = WH$ may be solved for Q. A series of curves was derived in this manner which provide the ventilation requirements for several conditions.

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Electric Tree Crusher

LIKE a harnessed tornado chewing its way through a forest, the machine described as a jungle-wrecker reportedly rips huge trees up by the roots, slaps them to the ground, then literally smashes them into splinters.

R. G. LeTourneau, Inc., of Longview, Texas, manufacturers, feel that the machine can effectively boost economic conditions and living standards in dozens of jungle-ridden countries by reducing cost involved in clearing jungle and semi-jungle areas. The greatest value of the machine is expected to be in such areas as Africa or South America where a single clearing project may involve 100,000 acres or more, according to the report.

Actually, this is the third tree crusher to be built by the company. Of the other two: one currently is ripping the right-of-way for a road through the jungles of Peru, while the other is undergoing testing on a 12,000-acre proving ground.

In operation, the crusher behaves much like a gigantic steam roller, except that it is many times heavier and infinitely more destructive. Working its way through a jungle, it leaves a 20-ft path and reportedly can clear an acre of land every 15 min. Only one man, perched in a cab high above the rollers, operates the crusher with push-button-type controls.

Length of the machine is 74.3 ft; width is 22 ft; height 19 ft; roller diameter 9 ft; roller base 49 ft; fuel capacity 1,000 gal; and weight is in excess of 140 tons.

Extending from the rollers are more than 300 heavy steel cleats, each shaped much like a conventional ax blade. When the machine is pitted against large trees, the front roller climbs the trunks until it has leverage enough to push the trees over. As the trees crash to earth, the machine's ax-like teeth dig in with the machine's weight.

On-the-Farm

S. M. Henderson
Member ASAE

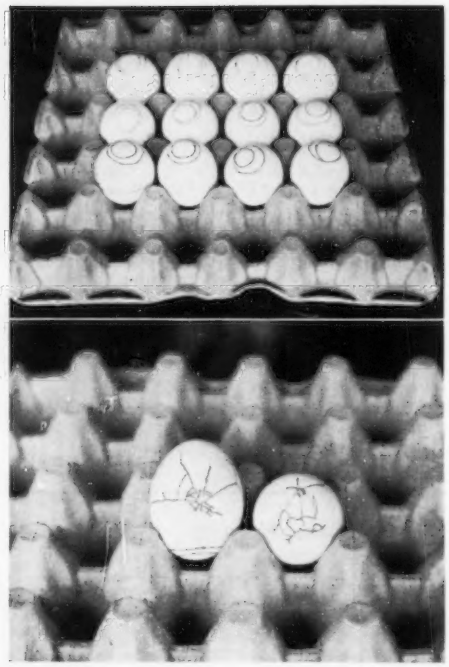

Fig. 1 Eggs used for moisture-loss studies. Beginning at the upper left the numbers correspond with those in Table 1. Below are the cracked eggs, Nos. 8 and 9, with cracks emphasized

AIR-CELL size, an important grade index, increases with loss of moisture from the egg. Moisture from the albumen and yolk permeates the shell and is evaporated or removed from the surface. A number of investigators (1, 2, 3, 4, 6, 7)* have observed or studied various factors of moisture loss. They generally recognize that rate of loss is: independent of air rate past the egg; related to egg size; dependent on relative humidity and temperature of the surrounding atmosphere; and variable with variations in permeability of the shell. Shell permeability seems to be unrelated mathematically to the factors that are believed or known to affect it: breed, health of bird, composition of feed, time of year, and age of bird. A single bird may produce eggs of variable day-to-day permeability although control factors are constant. Furthermore, permeability may increase as the egg ages, because of change in the organic materials in the shell and inner membrane pores. An increase in permeability usually does not become evident until the eggs have been in cold storage for two or three months or more.

Since moisture-loss rate is important to the design and management of a cold storage room, a study was designed to attempt to determine a moisture-loss index for predicting moisture loss under various storage conditions.

A dozen random fresh (white) eggs were candled and the air cell defined by a penciled line. Ten were weighed on a chemical balance and placed in a room at 53 F and 78 percent relative humidity. The eggs were so placed that local air rates varied from 50 to 640 fpm. They were weighed periodically for 20 days and candled at the end of the period, the air cell being again outlined by pencil, Fig. 1.

Pertinent data for each egg are listed in Table 1.

The results are shown graphically in Fig. 2. Data for the cracked eggs Nos. 8 and 9, are included only for general interest; they are not used in the computations. Following the eighth day of test, the relative humidity was raised to an average of 82 percent. Reductions in weight in grams per day for the first eight days, period I, and the last 12 days, period II, are noted in Table 1. The weight-loss rates were plotted against air rate and against egg weight. No relationship was shown in either case, indicating that shell permeability is the factor causing a variation in weight-loss rates. The experiment was not designed to isolate statistically each factor that might affect moisture-loss rate. Therefore the graphic treatment cannot be set out as conclusive evidence of the unimportance of these factors. Basically, the rate of moisture removal for any unit of ma-

*Numbers in parentheses refer to the appended references.

Part II of a paper presented at the annual meeting of the American Society of Agricultural Engineers at Roanoke, Va., June, 1956, on a program arranged by the Rural Electric Division. Part I was published in AGRICULTURAL ENGINEERING 38: 598, August, 1957.

The author—S. M. HENDERSON—is associate professor of agricultural engineering, University of California, Davis.

ACKNOWLEDGMENT: Thanks are due Dr. F. W. Lorenz, professor of poultry husbandry, University of California, Davis, for assistance and counsel that were invaluable in carrying out the studies.

TABLE 1. MOISTURE LOSSES IN INDIVIDUAL EGGS

Egg No.	Initial weight (gm)	Major and minor dimensions (in.)	Air rate* (fpm)	Air cell dimensions (inches) Height Initial	Height Final	Diameter Initial	Diameter Final	Weight-loss rate (gm per day) Period I	Period II
1	55.278	2.24—1.64	295	0.075	0.157	0.71	0.93	0.0441	0.0379
2	61.815	2.36—1.69	360	0.079	0.150	0.72	0.86	0.0497	0.0393
3	59.697	2.26—1.68	535	0.075	0.157	0.68	0.89	0.0566	0.0482
4	60.596	2.37—1.66	600	0.079	0.126	0.69	0.84	0.0382	0.0322
5	51.442	2.14—1.62	645	0.071	0.126	0.62	0.83	0.0421	0.0363
6	54.398	2.08—1.66	100	0.047	0.102	0.60	0.78	0.0320	0.0274
7	53.715	2.22—1.62	80	0.067	0.106	0.64	0.79	0.0356	0.0300
8†	50.879	2.16—1.60	85	0.067	0.165	0.67	0.96	0.067	0.0601
9†	57.552	2.23—1.68	65	0.075	0.173	0.69	0.98	0.118	0.101
10	59.249	2.35—1.69	95	0.063	0.142	0.68	0.88	0.0491	0.0400
11‡	—	2.16—1.64	—	0.079	0.126	0.71	0.87	—	—
12‡	—	2.17—1.67	—	0.040	0.138	0.56	0.85	—	—

*Approximate.
†Dropped and cracked on the second day, but kept on test. See Fig. 1.
‡Extras; stored in test room in one-dozen retail carton.

Egg Processing

Part II — Moisture Loss

terial is directly rated to area. We would, therefore, expect the rate here observed to be proportionate to egg area, other factors being constant. The permeability factor covers up the area factor, which could be isolated only by a carefully designed experiment with statistical replications.

The average weight loss per day for period I, excluding eggs 8 and 9, is 0.0408 gm, the standard deviation 0.00668; for period II it is 0.0342, the deviation 0.00555. Dividing the standard deviation by the average gives 0.163 and 0.162, indicating that two-thirds of eggs represented by the experimental sample will lose weight at a rate less than 16 percent removed from the averages noted.

Since the vapor pressure of eggs is nearly that of pure water, and since air rate has no apparent effect on moisture-loss rate, the theoretical moisture-loss-rate equation may be given as:

$$dw/d\theta = k\, p_s\, (100 - rb/100) \quad . \quad . \quad . \quad . \quad . \quad . \quad [1]$$

w = weight loss of an average egg (58 gm), gm per day

θ = time, days

p_s = vapor pressure of saturated air at the storage temperature, psi

rb = relative humidity, percent

k = moisture loss index, gm per day psi

k for period I is 1.01, for period II, 1.03. Therefore, a k of 1.02 is recommended.

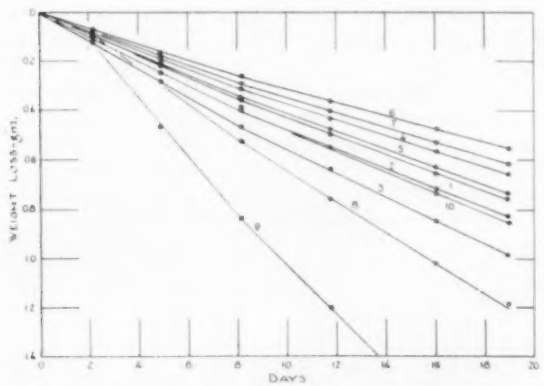

Fig. 2 Weight loss curves for eggs described in Table I

Although moisture loss during the "ranch storage" period does not result in immediate reduction in grade, it does result in weight loss and later grade reduction. Proper refrigeration design and operation can keep egg quality high

The shape of the blunt, or air cell, end of an average egg may be defined by the following equation:

$$x^2/(0.826)^2 + y^2/(1.024)^2 = 1 \quad . \quad . \quad . \quad . \quad . \quad [2]$$

which refers to the axis representation in Fig. 3.

The height of the air cell, h, in inches is:

$$h = 1.024 - \sqrt{1.05 - 0.385\, d^2} \quad . \quad . \quad . \quad . \quad . \quad [3]$$

d is the air cell diameter in inches

$$d = \sqrt{2.04h - h^2}/0.621 \quad . \quad . \quad . \quad . \quad . \quad . \quad [4]$$

The air cell volume, v, in cu in., is:

$$v = 1.46 + 0.680\, y^3 - 2.14\, y \quad . \quad . \quad . \quad . \quad . \quad . \quad [5]$$

in which

$$y = 1.024 - h$$

The air-cell height-to-diameter-and-volume relationships as defined by the above equations are shown by the curves in Fig. 4. The weight-loss curve, calculated from equation 5 is based on an air cell of 1.5 cm diameter before the egg begins to lose weight.

The diameter points are the candling dimensions recorded in Table 1 and include eggs Nos. 11 and 12. If it is recognized that actual air-cell dimensions are less than the dimensions plotted by the thickness of shell and inner membrane, the relation of the points to the curve is remarkably appropriate.

The weight-loss curve is based on the plano-convex space shown in Fig. 3. The actual air space is known to be double-convex or lens shaped. The plotted points are weight losses for the 20-day period. Since the points are above the curve, the double-convex shape is substantiated. Since the weights are not twice those indicated by the curve, the

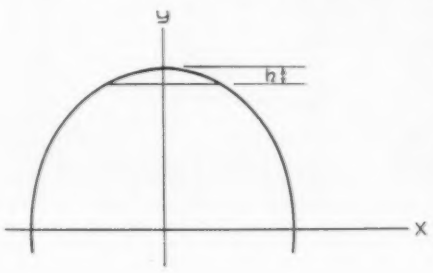

Fig. 3 Egg-shape geometry for calculating air-cell size

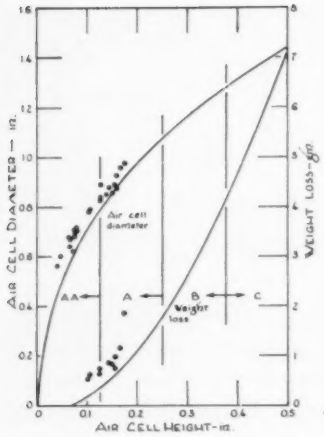

Fig. 4 Weight loss-air cell dimensions for standard egg showing grade limits

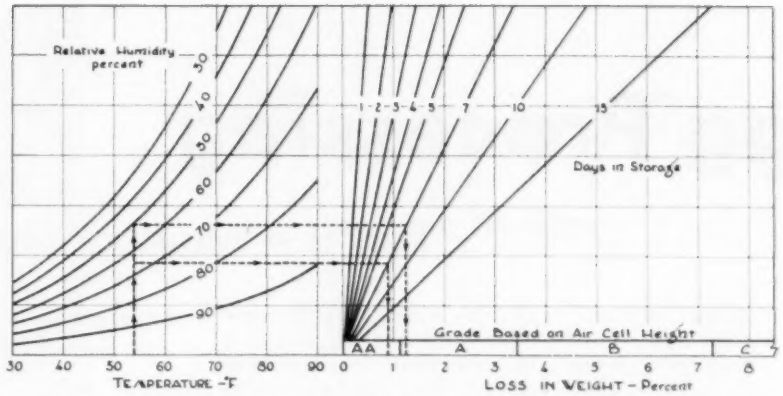

Fig. 5 Weight loss and grade reduction when fresh eggs are stored at a specific temperature and relative humidity for a specific time

. . . Egg Processing

curvature of the lower portion of the air cell is indicated as less than that of the upper portion.

The graph in Fig. 5 was designed from equations 1, 3, and 5. It permits one to estimate the reduction in grade from air cell enlargement under storage at a specific temperature and relative humidity for a specific period.

The chart (Fig. 5) is used by joining the storage temperature, relative humidity and time in sequence as shown by the dotted line. The example shows that storage for seven days at 54 degrees and 65 percent relative humidity will maintain the AA grade, although a significant weight loss will take place. Fifty percent relative humidity will cause the grade to reduce to A grade before the end of the storage period.

Moisture Loss in Containers

The containers in Fig. 6 were filled with fresh eggs and stored at 58½ F and 70 percent relative humidity for 24 days in an air rate of about 70 fpm. Ten independently supported and completely exposed eggs were used as a check on performance. The exposed eggs were weighed twice during the 24-day period. The eggs in containers were weighed only before and after the test period so that the inner container atmosphere would not be disturbed during the test. The eggs in each flat were weighed as a group in order to determine the end and ventilation effects.

The eggs averaged 58 gm each in the basket (216 eggs); 53 in the cases; and 52 for the ten exposed.

Results

The results are reported in the bar graph, Fig. 7. There appears to be no significant difference between moisture-loss rates in the basket and in the wood case, even though the filler-flat system appears inferior to fillers and flats and the basket. The effect of cross air movement is evident. The fiber carton is superior, with the ends of the container losing moisture faster than the central part.

The rate of loss for the exposed eggs was slower than that indicated by equation 1 but was within the standard deviation range discussed previously.

Conclusions

The candled appearance of the air cell is not representative of the true space. The space is larger than indicated, and double-convex rather than plano-convex.

The amount of moisture lost during the generally short storage period on the farm, as shown in Fig. 5, appears so small that little attention need be given to designing for very high relative humidity. Note, however, that even though the loss during the three or four-day period at 55 F or lower is insufficient to shift eggs out of AA grade, there is a significant reduction in weight. Since additional moisture removal continues during commercial or retail storage, a grade drop may result soon after eggs leave the farm. It is therefore advisable to design and operate the refrigeration system for a reasonably high relative humidity.

(Continued on page 34)

Fig. 6 Containers used for storage moisture-loss studies. Note that one-half of the 30-doz case contains filler-flats, the other one-half fillers and flats. The weight and pan were used to produce a top closure comparable to sealing

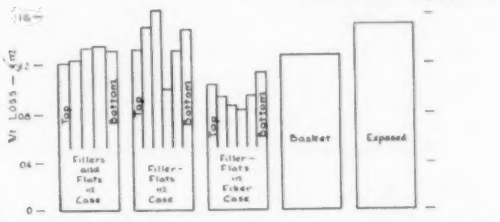

Fig. 7 Weight loss of stored eggs for 24-day period adjusted for a 58-gm egg

Statistics Help Evaluate Functional Components of Farm Machinery

William T. Mills
Assoc. Member ASAE

David D. Mason

The authors, having tried statistical methods for determining peanut damage during harvest, recommend further use in evaluating functional components of farm machinery

DURING the past few years many industries and institutions have made increasing use of a most important research tool. This tool is the rapidly expanding field of experimental statistics. It is the opinion of the authors that workers in the agricultural machinery field should make fuller use of this important research tool.

Many people look upon statistical methods as merely the arranging of data so that the results will lead toward a desired conclusion. It is true that some investigators feel compelled to adjust their hypotheses after the data have been collected and analyzed. However, statistical methods when properly applied lead to efficient design of experiments and permit the extraction of the maximum amount of information from research data.

Statistical methods need to be used especially in evaluating the functional components of farm machinery by agricultural engineers because they must deal with both physical and biological systems. Generally, the experimental conditions in physical systems may be more closely controlled than those in biological systems, although both are subject to variation which must be considered in evaluating results. For example, in the laboratory the temperature, pressure, etc., can be controlled within a relatively narrow range, but in the field the research worker has very little control over those factors. Therefore, if these variables change from one test to the next, there will be uncertainty in any measure of the effect of a treatment on a machine characteristic. For example, in a recent experiment to evaluate peanut damage in a carding type peanut picker using a standard screen and an oversized screen, eight samples for each screen were collected each day for two days. The analysis of the data indicated that the oversized screen treatment resulted in 9.5 percent fewer peanuts damaged than the standard screen treatment. It was first concluded that the oversized screen caused fewer peanuts to be damaged. This appeared to be a logical conclusion because 9.5 percent was quite a large difference. The fallacy of this conclusion, however, was that part or maybe all of this difference was caused by the effect of random variation. Actually in this case it was later found that with the scheme used in this test, on the average a difference of nearly 16 percent would be required for significance at the usual 5 percent probability level. This adds suspicion to the conclusion reached in the above experiment.

Basic principles of experimental design are used to provide an unbiased estimate of the mean difference between

Paper presented in part at the Winter Meeting of ASAE in Chicago, Ill., December, 1955, as a contribution to the Power and Machinery Division. Approved by the Director of the North Carolina Agriculture Experiment Station as Paper No. 710 in the journal series.

Authors—WILLIAM T. MILLS and DAVID D. MASON—are, respectively, research instructor in agricultural engineering and professor of experimental statistics, North Carolina State College.

Fig. 1 *(Left)* This oversized picking screen appeared to damage fewer peanuts than the regular screen, but this difference was not significant when the test data was subjected to statistical analysis • Fig. 2 *(Right)* Samples collected from this (carding) peanut harvester each day for five days to measure picking efficiency showed considerable variation from one day to the next

Fig. 3 Although the results from this (cylinder) peanut harvester did not vary as much as the carding unit the day to day variations were still large

. . . Statistics

two treatments (*e.g.*, comparison of the standard and oversized screen mentioned above), together with confidence limits on that difference. Briefly, all identifiable sources of variation are removed by blocking or stratifying, and the remaining variation is allotted equally, on the average, by the device of randomization. From this random variation the experimental error is computed. This estimate of error provides a basis of making probability statements about the reality of the estimated differences.

If preliminary information on the magnitude of the components of variation making up this experimental error is available, estimates of the optimum pattern of sampling may be made. In this particular experiment, two major components of variation comprise the experimental error; namely, *(a)* the failure of the differences between treatments to be consistent from day to day (V_{DT}), and *(b)* the failure of the differences between treatments to be consistent between replications within a given day (V_E). Thus, the variance of a treatment mean $(V_{\bar{x}})$ is:

$$V_{\bar{x}}=(V_{DT}/d)+(V_E/dr) \quad . \quad . \quad . \quad . \quad . \quad [1]$$

where d is the number of days over which the experiment is conducted, and r the number of replications per day.

The variance of the difference between two treatments is:

$$V_{\bar{d}}=2\,[(V_{DT}/d)+(V_E/dr)] \quad . \quad . \quad . \quad . \quad [2]$$

The square root of $V_{\bar{d}}$ gives the standard error of the difference. Confidence limits on the estimated difference may be computed by multiplying the standard error of the difference by "Students t" for the confidence level desired. These confidence limits at the 95 percent probability level are usually designated as the "least significant difference" (L.S.D.).

In order to determine the normal variation in peanut damage resulting from uncontrollable variables, an experiment was designed to deliberately collect samples from five replications per day for five days. This design allowed an estimate of the replication to replication differences as well as an estimate of day to day differences in peanut damage to be computed. From these estimates the L.S.D. between treatments, that could be detected when measuring peanut damage, was computed and tabulated. These L.S.D. values are actually estimates of "limits of errors" of differences between treatments to be expected on the average in future trials. They may be used as a guide in the design of such experiments, once the required precision (size of L.S.D. desired) is decided upon. The L.S.D. values for peanut damage were tabulated as shown in Table 1, which allows the investigator to choose the sampling scheme, *i.e.*, the number of replications and the number of days that will best fit his limitations. The least significant difference detectable between treatments, when eight replications per day for two days are used, is shown in Table 1 to be 15.71 percent as was mentioned above. Looking further into Table 1, it can

TABLE 1. CARDING UNIT, LEAST DIFFERENCE IN DAMAGE DETECTABLE BETWEEN TREATMENTS FOR DIFFERENT SAMPLING SCHEMES

(Detectable difference values are based on 25 degrees of freedom and the 5 percent significance level.)

Replications per day	Days 2	4	8	16
	L.S.D. percent*			
1	18.16	12.84	9.08	3.12
2	16.80	11.88	8.40	2.88
4	16.08	11.37	8.04	2.76
8	15.71	11.11	7.86	2.70

*Least significant difference detectable

TABLES 2, 3, 4. LEAST DIFFERENCE DETECTABLE BETWEEN TREATMENTS FOR DIFFERENT SAMPLING SCHEMES

(Detectable difference values are based on 25 degrees of freedom and the 5 percent significance level.)

Replications per day	Days 2	4	8	16
	L.S.D. percent*			
Table 2 Carding Unit (picking efficiency)				
1	1.20	0.85	0.60	0.42
2	1.14	0.81	0.57	0.40
4	1.11	0.78	0.55	0.39
8	1.09	0.77	0.55	0.38
Table 3 Cylinder Unit (picking efficiency)				
1	0.60	0.42	0.30	0.21
2	0.55	0.39	0.27	0.19
4	0.52	0.37	0.26	0.18
8	0.51	0.36	0.25	0.18
Table 4 Cylinder Unit (damage)				
1	8.11	5.74	4.06	2.87
2	6.30	4.45	3.15	2.23
4	5.15	3.64	2.58	1.82
8	4.48	3.16	2.24	1.59

*Least significant difference detectable

TABLE 5. CARDING UNIT, LEAST DIFFERENCE IN DAMAGE DETECTABLE BETWEEN TREATMENTS AND COST ESTIMATES FOR DIFFERENT SAMPLING SCHEMES

(Detectable difference values are based on 25 degrees of freedom and the 5 percent significance level.)

Replications per day	Days							
	2		4		8		16	
	Cost	L.S.D. %*	Cost	L.S.D. %*	Cost	L.S.D. %*	Cost	L.S.D. %*
1	$11.70	18.16	$23.40	12.84	$ 46.80	9.08	$ 93.60	3.12
2	15.50	16.80	31.00	11.88	62.00	8.40	124.00	2.88
4	23.10	16.08	46.20	11.37	92.40	8.04	184.80	2.76
8	38.30	15.71	76.60	11.11	153.20	7.86	306.40	2.70

*Least significant difference detectable.

be seen that if the total number of replications used (16, eight per day for two days) had been collected at the rate of one per day for 16 days a 3.12 percent difference could have been detected. That is to say that a difference of 3.12 percent or greater would on the average indicate a real difference between treatments at the 5 percent probability level. This scheme would have been five times more sensitive than the one actually used.

This type of table may be drawn up for each characteristic to be studied. For example, Tables 2, 3, and 4 illustrate values for other characteristics as well as values for the same characteristic but for another machine. Table 2 is for picking efficiency for a carding type peanut picker while Tables 3 and 4 are for picking efficiency and peanut damage respectively in a cylinder type peanut picker.

It is not intended to specify the requirement that a uniformity trial such as that described above must be conducted prior to each experiment. If, on a basis of previous experiments and experience, an estimate of the error components may be made, such estimates may be used in determining the size of the experiment. Also, by collecting some additional data in the course of an actual experiment, additional information that will be helpful in the design of future trials is often obtained.

For each experiment there will be a most efficient combination of cost, time, and accuracy. Table 5 shows the cost of each sampling scheme as well as the L.S.D. values. From this table the investigator may design an experiment that will produce the most information in the shortest length of time and at the least expense.

An alternative statistical approach is to estimate the optimum sampling scheme (in terms of the number of replications to be taken per day) that will provide the most information per unit cost. Then, the number of days required to sample is easily determined by substitution in equation [1] for a given level of precision (expressed by $V_{\bar{x}}$). This approach is discussed in detail in Cochran (1)*.

*Numbers in parentheses refer to the appended references.

TABLE 6. OPTIMUM NUMBERS OF SAMPLES (REPLICATIONS) PER DAY FOR DIFFERENT COST AND VARIANCE RATIOS.

Cost Ratio (C_D/C_R)	Variance Ratio (V_{DT}/V_R)			
	1	4	12	20
1	1.00	0.50	0.29	0.22
4	2.00	1.00	0.55	0.45
12	3.46	1.73	1.00	0.77
20	4.47	2.24	1.29	1.00

In this procedure, it is necessary to provide a cost function, which is a quantitative expression of the composition of the total cost of determining a treatment mean. In the example given, the simplest form of such a function would be:

$$C_T = d\,C_D + d\,r\,C_R \quad . \quad . \quad . \quad . \quad . \quad . \quad [3]$$

where C_T is the total cost of determining a treatment mean, C_D is the cost associated with the operation of making a day's run, and C_R is the cost of running one replication on a given day, with d as the number of days and r the number of replications run per day.

The simultaneous solution of equation [3] and equation [1], for r, to minimize cost per unit information (where information is defined as $1/V_{\bar{x}}$ gives:

$$r\ (\text{optimum}) = \sqrt{(V_R/V_{DT})(C_D/C_R)} \quad . \quad . \quad . \quad . \quad [4]$$

With specific information about each of the components on the right side of the equation, point estimates of r (optimum) may be made. Or, one may compute a general table for different values of V_R/V_{DT} and C_R/C_D, that may be used as a guide for a range of situations. Table 6 illustrates the latter computation, in the type of arrangement given by Peterson and Chamblee(2).

From this generalized table, it is obvious that the optimum number of replications per day increases with *(a)* increasing ratio of cost for operating for a given day, to cost for taking a given replication within a day and *(b)* decreasing ratio of the day-to-day variance component (V_{DT}) to replication-to-replication within a day (V_R). That is, more replications per day are taken as optimum either as replication-to-replication variation increases, or as cost of taking an additional replication is decreased.

This application is an example of the value of statistical methods in farm machinery research.

To summarize briefly, there are three main points to remember: *(a)* Statistical methods are important for efficient evaluation of functional components of farm machinery; *(b)* For each experiment there is a most effective combination of time, cost and accuracy, and *(c)* One method of determining the most effective combination of these factors is by tabulating an L.S.D. table for the characteristic and machine under study.

In conclusion statistical methods offer a more efficient use of your time, money and manpower. It can also mean a steadier progress in improving farm machinery.

References

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2 Peterson, R. G. and Chamblee, D. S. Optimum size of sample for hand separation of forage crop mixtures into their component species in small plot experiments, Agronomy Journal, Vol. 47; 20-23, 1955.

. . . Egg Processing

(Continued from page 30)

Moisture-loss rate can be reduced by storage of eggs in containers, with fiber cartons being superior.

Even though a significant moisture-loss index was derived, natural variation of the physical features indicates the need for more extensive and statistically designed studies if generally reliable procedures for predicting amount of moisture loss are to be made available.

References

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6 Smith, A. J. M. Evaporation from eggs in standard packages. Report of the Food Investigation Board, Dept. of Sci. and Ind. Res. (British) p. 148-152, 1931.

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Correction

Figs. 8 and 9 on page 861 in the article, entitled "Density: A Tool in Silo Research," by C. K. Otis and J. H. Pomroy, were transposed in error as they appeared in the December, 1957, issue.

Statement on Professional Registered Engineers

THE Engineers Joint Council has a committee whose objective is to bring together the viewpoints of the various member societies into a unified statement representing the engineering profession on the subject "Practice of Engineering." Statements from different societies have varied considerably. Following is a statement of the ASAE position which was prepared by ASAE Council members G. M. Eveleth, chairman; H. J. Barre and W. H. Worthington, and which was approved by the ASAE Council at its Winter Meeting.

"Professional responsibility for engineering work is a personal responsibility which should be recognized as such by all laws relating to the registration or licensure of the professional engineer. There should be no discrimination by implication, omission, or direction as to the form of business organization, individual partnership, corporation or other. With respect to legislation which discriminates as to the form of business organization that may furnish the services of engineers in public practices, the ASAE recommends that the public practices of engineering should be permitted to engineers employed by any type of firm provided the engineers in responsible charge are registered in the State having jurisdiction. While we in ASAE wish to encourage registration of agricultural engineers for non-public practice as well as public practice, we are opposed to legislation that would require compulsory licensing of engineers who practice in the non-public field."

Committee on Radiation Report

THE Committee on Radiation has been assigned the function of giving particular attention to the Society's interests in atomic radiation and nuclear engineering. This supplement to the report from John E. Nicholas, chairman, ASAE Committee on Radiation, which appears in the December, 1957, issue of the Journal, lists some of the phases and applications of radiation in the hopes that it may encourage agricultural engineers to develop their interest in radiation and to identify themselves with agricultural engineering progress in utilizing it.

Known Agricultural Uses for Radiation

- Tracer studies in plants
- Bush beans—germination rate, sex, ratio and mutation
- Rate of bone calcification—effect of vitman D
- Development of new plant varieties—breeding
- Absorption in animals and distribution in chickens of carbon 14
- Metabolism in sheep by cobalt carbonate and cobalt sulfate
- Radiobiological study of enzymes
- Phosphate tracer in production of fertilizer
- Placement and uptake studies of fertilizer in plants and plant leaves
- Effects of radiation on foods and on spoilage organism
- Effects of density of ions in air, and animals

Use of Radioisotopes in Metabolic Studies

- adipic and citric acids on animals
- amino acid by microorganisms
- antibiotics
- antimony oxide
- carbohydrate
- carbon-14 in animals
- cobalt carbonate and cobalt sulfate in sheep
- copper carbonate and copper sulfate in cattle
- dithymol dixdide in cattle
- glucose by bacteria
- iron and manganese as dietary mineral supplements
- isonicotinic acid and hydrozide in animals
- labeled compounds in animals
- labeled drugs in animals
- molds in relation to penicillin production
- monochloracetic acid
- nerve tissue
- potassium iodide, iodinated protein and iodinated fats in rats
- riboflavin
- sodium phosphate, iron phosphate ferrum reductum and iron sulfate in cattle
- steriods
- sulfur dioxide treated silage
- virus infected tissues
- vitamin B_{12}
- yeasts
- zinc chloride and zinc carbonate in cattle

Following are brief reviews of papers presented at ASAE meetings or other agricultural engineering papers of which complete copies are available. Information concerning copies of these papers may be obtained by writing to the American Society of Agricultural Engineers, St. Joseph, Mich.

Influence of Basic Tillage Methods on Corn Yields and Harvestability, by H. P. Bateman, assistant professor of agricultural engineering, University of Illinois. Paper presented at the Golden Anniversary Meeting of ASAE in East Lansing, Mich., June, 1957, on a program arranged by the Power and Machinery Division. Paper No. **57-102.**

The results of four years of tillage studies at the University of Illinois are presented in this paper. The three basic tillage methods studied for corn production, namely: turning under the crop residue, mixing it throughout the tilled layer and leaving the residue on the surface as a mulch are compared for the 40-in. and 40 to 90-in. row spacing methods. The conventional method of preparing the seedbed is compared with seedbeds prepared with less operations by conventional machines, a rotary tiller and two new types of mulch planters. The yield results presented have been for growing corn each year with adequate amounts of fertilizer applied.

Automation in the Poultry Industry, by A. William Jasper, managing editor, POULTRY TRIBUNE, Mount Morris, Ill. Paper presented at the Golden Anniversary Meeting of ASAE in East Lansing, Mich., June, 1957, on a program arranged by the Electric Power and Processing Division. Paper No. **57-62.**

The major advantage of automation is economic, according to this paper which discusses the subject of automation in the poultry industry, thus automation features and programs should be analyzed on a unit cost basis. It is stated that intelligently applied, automation will result in better quality products, fewer rejects, and less waste of manpower and equipment, bringing an overall reduction in production and marketing costs.

Some of the benefits of automation discussed are the saving of costly hand labor; cleaner, higher quality eggs; larger, more efficient units; decreased cost per unit; higher return on investment; more efficient use of key people; drier litter; fly and disease control and higher egg production. Automation should be approached on a teamwork basis and include all classes of engineers, poultry husbandmen, marketing specialists, and economists.

To achieve the ultimate in automation it is reported that complete environment control in the hen house will be a necessity.

Proceedings of the Agricultural Engineering Graduate Teaching Seminar, held at the Golden Anniversary Meeting of ASAE in East Lansing, June, 1957. Prepared by the ASAE Committee on Graduate Instruction. Paper No. **57-40.**

This is a report of the Agricultural Engineering Graduate Teaching Seminar which was held during the Golden Anniversary Meeting. The contents include the program, attendance list, discussions on the M.S. degree and Ph.D. degree programs, and papers on various subjects related to a graduate training program in colleges. General recommendations for research and thesis requirements; course requirements; standards, subject matter, and administration are also presented.

The Design of Irrigation Ponds Using Pond and Ground-Water Storage, by Irwin Remson and J. R. Randolph, geologists, Ground Water Branch, U. S. Geological Survey, Seabrook, N. J. Paper presented at the North Atlantic Section Meeting of ASAE at the University of Delaware, August, 1957. Paper No. **57-37.**

Increasing numbers of artificial ponds using ground-water storage, are being used for irrigation in the coastal plain of New Jersey. Theoretical methods are needed to supplement the empirical criteria currently used for the design of these ponds. Equations and curves are presented which relate the pond discharge and drawdown to pond dimensions and hydrologic properties of the aquifer. The equations and curves reportedly can be used to determine the pond dimensions and drawdowns needed to obtain the desired discharges under given hydrologic conditions.

A New Light-Weight Trussed Rafter, by G. L. Nelson, G. W. A. Mahoney and J. I. Fryrear, Agricultural Engineering Dept., Oklahoma State University, Stillwater. Paper presented at the Winter Meeting of ASAE in Chicago, Ill., December, 1957, on a program arranged by the Farm Structures Division. Paper No. **57-571.**

Experiments, conducted with trussed rafters on vertical deflection at the ridge, horizontal deflection at the heel, and strain in the top chord under long duration (up to 5 weeks) and short duration gravity loads, are discussed in this paper. From the results of these experiments a light-weight trussed rafter was developed and load tested under gravity loads of 6 weeks maximum duration. The performance of the light-weight design with casein-glued joints is reported as comparable to the best conventional design previously tested.

Advantages of the light-weight design were found to be the elimination of almost all precision cutting of lengths or angles of members, elimination of waste of wood that normally occurs in dressing lumber, increased structural efficiency in use of wood, elimination of cutting and installation of splice or gusset plates, and lighter weight.

Maintenance of Grasses, by Fred V. Grau, chief agronomist, Nitro-Form Agricultural Chemical Co., Woonsocket, R.I. Paper presented at the Golden Anniversary Meeting in East Lansing, Mich., June, 1957, on a special program arranged by the Soil and Water Division for Public Lands and Public Works. Paper No. **PL-12.**

Maintenance of grasses implies the basic concept that, by fertilizing, mowing, rolling and watering, the condition of the area is improved for use by man. This paper discusses the fact that maintenance is influenced by specific requirements of the grasses involved and by the specific requirements of the intended use of the area.

Extremes of variations range from zero maintenance to daily attention. Selection of the grass or legume to suit the maintenance or the use requirement is a very important factor. Improved strains should be used wherever possible. They are better able to utilize fertilizer, to resist diseases, to tolerate drought and wear.

Rolling, aerating, topdressing, pest control all enter into grass maintenance. A management program is only as good as the turfgrass superintendent in charge.

Grass Maintenance Equipment, by J. R. Watson, chief agronomist, Toro Manufacturing Co., Minneapolis, Minn. Paper presented at the Golden Anniversary Meeting of ASAE in East Lansing, June, 1957, on a special program arranged by the Soil and Water Division for Public Lands and Public Works. Paper No. **PL-13.**

Certain basic units of equipment are required to properly maintain grass areas and these are discussed in this report. The type and amount of turf maintenance equipment should be selected on the basis of the level of maintenance, the size, landscaping, kind of grass and use to which the turfgrass will be subjected.

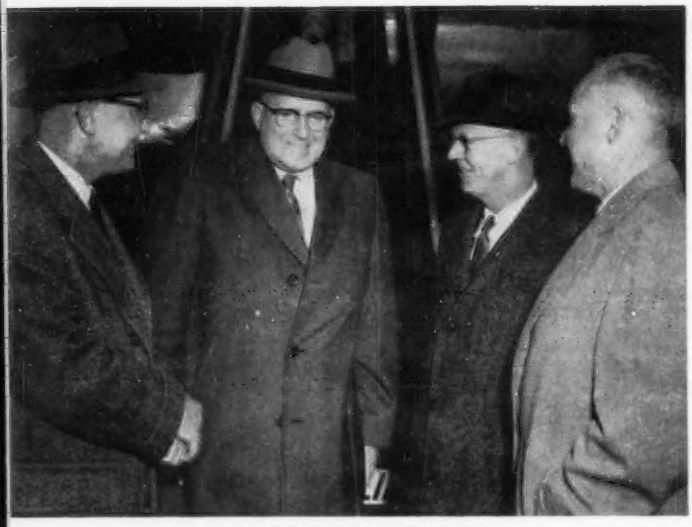
Grass cutting is the most time consuming phase of turfgrass maintenance, and one of the most important factors contributing to good turfgrass appearance. The type, size, design and maneuverability of mowers are important from the standpoint of efficient operation. Four basic types of mowers are discussed such as reel, rotary, sickle and vertical, including hammerknife. Each type has certain advantages and disadvantages which should be considered when a selection is made.

Most fertilizer spreaders will double as seeders. Spreader-seeders are essential for uniform distribution of fertilizer, seed and topdressing material. Most herbicides and fungicides used on turf require only sufficient volume of spray material to give uniform coverage.

Water Management in Cranberry Bogs, by J. Bornstein and D. R. Sheperd, respectively, agricultural engineer, (SWCRD, ARS) USDA, Burlington, Vt., and SCS, Hyannis, Mass. Paper presented at the North Atlantic Section meeting of ASAE in Newark, Dela., August, 1957, on a program arranged by the Soil and Water Division. Paper No. **57-41.**

The Soil Conservation Service engineers and conservationists use a number of drainage structures to control excess water in cranberry bogs. The main channels carry water through the bogs and pick up drainage from lateral ditches in the bog. Upland ditches are located around bogs to catch flow from upland areas. To get the water safely through bog dikes, timber, concrete and corrugated metal flumes or water control structures are designed. For these structures the design section of the SCS at Upper Darby, Pa., is preparing a series of standard designs. With one or more of these standard plans supplied by the conservationist the grower can build structures that are structurally sound and hydraulically adequate for controlling water level in his bog.

WINTER MEETING
High Lights



Honorable George D. Clyde, governor of Utah, was greeted at the airport in Chicago by a group of ASAE officials. *(Left to right)* Earl D. Anderson, president of ASAE; Governor Clyde; K. H. Beauchamp, chairman of Soil and Water Division; and J. Roberts, chairman of Education and Research Division

Governor Clyde of Utah spoke during the general session Tuesday afternoon, December 17, on reclamation and the agricultural surplus

TOTAL registration mounted to 1132 during the Winter Meeting of the American Society of Agricultural Engineers held at Edgewater Beach Hotel, December 15-18. Technical sessions, committee meetings and other professional activities were in progress almost continually during the 4-day meeting.

The ASAE Council met Saturday afternoon, most of Sunday, and at various other times to dispose of a variety of administrative matters. The Cabinet meeting held Sunday afternoon was well attended. Earl D. Anderson, president of ASAE, reported on the fine spirit displayed by the members during his many visits to Section meetings. Lloyd Lamouria, representative of the Pacific Coast Section, extended an invitation to the 51st Annual Meeting to be held on the Santa Barbara Campus, University of California, June 22-25.

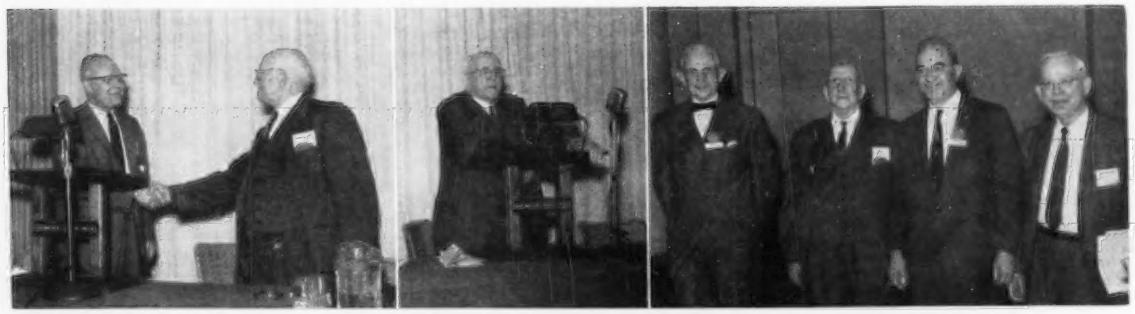
An oversight of 50 years was corrected at a special business meeting held Tuesday afternoon when Elmer W. Hamilton was recognized as a charter member of ASAE. This action followed the uncovering of supporting evidence by the committee on ASAE history indicating that Mr. Hamilton personally attended the organizational meeting of the Society in December, 1907. The special business meeting was called for the purpose of considering amendments to the ASAE Constitution. Proposed changes are explained on page 15 in this issue.

The Honorable George D. Clyde, of Utah, spoke on reclamation and the agricultural surplus during the general session on Tuesday afternoon. Other noted speakers on the general session program included: Dr. Glenn Murphy, professor and head, department of theoretical and applied mechanics, Iowa State College, who spoke on the applications of similitude theory to agricultural engineering research; Dr. Henry E. Bent, dean of graduate school, University of Missouri, Columbia, who talked on fundamental research — pinnacle or foundation; and Dr. C. E. Barthel, Jr., assistant director, Armour Research Foundation, Illinois Institute of Technology, Chicago, presented a talk on industrial research.

Monday afternoon, December 16, at a special session the Farm Structures Division milker was held. A movie on the salesman was shown and a talk on peanuts was given by Cloyd Steinmetz, followed by a dairy smorgasbuffet. Monday evening two concurrent special programs were featured: the

(Continued on page 46)

Charter Member Recognized



An oversight of 50 years was corrected at a special business meeting during the Winter Meeting when Elmer W. Hamilton was recognized as a charter member of ASAE. • *(Left)* ASAE President Earl D. Anderson greets Mr. Hamilton as a charter member. • *(Center)* Mr. Hamilton expressed his gratitude by thanking those who, as he said, "had taken the time and trouble to pull out an old nail that had been rusting for practically 50 years, straighten out the kinks and brighten it up a bit." • *(Right)* Among the first to offer congratulations were *(left to right)* Raymond Olney, ASAE counselor; Roy Bainer, past-president of ASAE; and Mack M. Jones, chairman of agricultural engineering dept., University of Missouri

Golden State in '58

"Golden State in '58," motto for the 51st Annual Meeting to be held on the Santa Barbara Campus, University of California, June 22 to 25, received much attention as is shown in two photos above. The Pacific Coast Section, sponsors of the coming meeting, arranged to have a beautiful model on hand to pass out samples of West Coast delicacies

FEI Award Winners

(Above) Recipients of the 1957 FEI Gold Awards "for outstanding accomplishments and service to industry engineers" were William J. Coultas *(left)* of Deere and Co., East Moline, Ill., and Charles J. Scranton *(right)* of Allis-Chalmers Mfg. Co., LaPorte, Ind. George A. Kelly II, chairman, FEI executive committee *(center)*, made the presentations during the 12th Annual "Dinner for Professors" held in conjunction with the ASAE Winter Meeting

(Right) Unscheduled corridor sessions are important adjuncts to ASAE meetings. The following *(shown left to right)* were snapped during such conferences:

(A) W. E. Wayland, sales manager, agricultural original equipment div., Dayton Rubber Co.; John M. Sterley, industrial products sales div., B. F. Goodrich Co.; and Arnold B. Skromme, chief product engineer, John Deere Spreader Works

(B) Merlin Hansen, chief engineer, new products, John Deere Research and Engineering Center; and T. J. Thaden, chief engineer, agricultural tire development, Goodyear Tire & Rubber Co.

(C) John G. Sutton, drainage engineering specialist, Soil Conservation Service, USDA; and H. H. Nuernberger, head, agricultural section, development div., Aluminum Co. of America

Newly Organized South Carolina Section

The South Carolina Section held an organizational meeting, November 22 at Clemson House, Clemson, S. C., following Iowa to become the second new section to be formed in 1957. The group was welcomed by R. F. Poole, president of Clemson College. Special guests included J. L. Butt, secretary of ASAE, who spoke on ASAE — its impact on the future; R. H. Driftmier, past-president of the Society, speaker at the Section banquet; and G. E. Henderson, ASAE Councilor and coordinator of the Southern Association of Agricultural Engineering and Vocational Agriculture, who, with G. W. Giles, discussed state sections and their influence on progress.

Speakers through the day discussed the history, role, contribution, and future challenges to the agricultural engineer. The origin and growth of agricultural engineering in South Carolina was presented by J. T. McAlister, and George B. Nutt, past-president of ASAE, spoke on challenges facing the agricultural engineer. J. H. Sams discussed the agricultural engineer and his profession, and agricultural engineering activities at Clemson College were presented by A. W. Snell, M. C. McKenzie, J. H. Anderson and J. A. Luscombe. R. H. Herron outlined activities of the South Carolina student branch of ASAE.

A business meeting closed the afternoon session. Officers elected for the new group are W. C. Dozier, section chairman; J. T. McAlister, M. C. McKenzie, and M. T. Gettings, vice-chairmen; and E. B. Rogers, secretary-treasurer. A. W. Snell was chairman of the organizational committee.

J. L. Butt Named "Executive Secretary"

Following a suggestion by President Anderson, the ASAE Council has authorized use of the title "Executive Secretary" by the Secretary of the Society. This action was taken by the Council during its meeting in Chicago in December.

The Council acted under its authority to amend the Society's By-Laws and Rules. It voted to amend Article R8 of the Rules by the addition of a rule to read "Rule 2 The Secretary is authorized to use 'Executive Secretary' as his official title."

In taking this action, Council noted Sec. 3, Article C8 of the Constitution, which specifies that, "The Secretary shall be the executive officer of the Society under the direction of the Council." The new rule and practice of using the title "Executive Secretary" will clarify the nature of his duties and the extent of his authority for the information of all concerned.

Tax Reduction

The personal expense involved when serving on Society committees has been found to be deductible from the income tax. The following information has been sent out by the Engineers Joint Council and confirmed by their legal counsel as being correct:

The Internal Revenue Service under ruling 55-4, I.R.B. 1955-1 states that a taxpayer "who gives his services gratuitously to an association, contributions to which are deductible" under the relevant provisions of the Code "and who incurs unreimbursed traveling expenses, including the cost of meals and lodging, while away from home in connection with the affairs of the association and at its direction may deduct the amount of such unreimbursed expenses in computing his net income;" subject, however, to the limitation in respect to all gifts made to exempt organizations of our type; namely, that the total amount of such gifts made in any one year may not exceed 20 percent of the donor's gross income for each year. This limitation means that while such expenses are deductible they are included with other gifts in computing the 20 percent limitation.

National Electrical Week

National Electrical Week is scheduled for February 9-15. It is held each year during the week of February 11, the birthday of Thomas A. Edison. This week was chosen because of Edison's role in electrical progress and because his birthday is recognized as a significant date which highlights the importance and benefits of electricity and the electrical industry. It is an all-industry event, sponsored or endorsed by 26 leading trade associations in the electrical industry, representing electrical manufacturers, power suppliers, distributors, dealers, contractors, inspectors, engineers, wiremen, and electrical leagues.

The principal objective of National Electrical Week is to focus attention on the contributions of electricity to our economy and way of life. It is carried out as an "umbrella activity", as a beginning of the year springboard for all the various programs and educational or promotional objectives of the industry.

Science Youth Day will be observed February 11 as an educational effort sponsored by the International Edison Birthday Celebration Committee and The Thomas Alva Edison Foundation, Inc., to encourage young people in greater numbers to take advantage of the growing opportunities for careers in science and engineering; stimulate greater interest in science education and the world of technology emerging from the nation's 4,000 research laboratories; and focus national attention on the critical shortage of scientists and engineers.

Further information about National Electrical Week may be obtained from: Headquarters, National Electrical Week Committee, 290 Madison Ave., New York 17, N. Y.

Nuclear Congress Programs

Copies of the program for the 1958 Nuclear Congress to be held at the Chicago Amphitheatre, Chicago, Ill., March 16-21, will be available from ASAE Headquarters, St. Joseph, Mich.

Founders of South Carolina Section

(Above) Members of ASAE who met November 22 at Clemson, S. C., to form a new South Carolina Section.

(Right) Leaders in the organization of the new Section were (LEFT TO RIGHT) A. W. Snell of Clemson, chairman of the organizing committee; W. C. Dozier, chairman of the South Carolina Section; J. L. Butt, secretary of ASAE; R. H. Driftmier, University of Georgia, past-president of ASAE; and G. E. Henderson, University of Georgia, ASAE councilor and coordinator of the Southern Association of Agricultural Engineering and Vocational Agriculture.

T. E. LONG

M. L. BURGENER

L. A. DYKE

Thomas E. Long has been appointed assistant to the vice-president for promotion of the Portland Cement Assn. Mr. Long joined the Association in November, 1947, as assistant manager of the farm bureau, and became manager the following August. Prior to joining the Portland Cement Assn., he served for three years as agricultural engineer in the commercial research div. of Republic Steel Corp. From 1939 to 1944 he was on the staff of the North Dakota State College, where he was responsible for the development of an irrigation experimental research farm.

Mr. Long graduated from the University of Nebraska with a B.S. degree in agricultural engineering, and has since completed additional structural, highway and sanitary engineering studies at the Illinois Institute of Technology. He is a registered professional engineer in N. D.

Maurice L. Burgener was appointed as manager of the farm bureau of the Portland Cement Assn. to succeed Thomas E. Long, who was made assistant to the vice-president.

Mr. Burgener joined the Association in August 1949 as agricultural engineer in the farm bureau. He received B.S. and M.S. degrees in agricultural engineering from the University of Illinois and is a member of Tau Beta Pi, an honorary engineering fraternity. He has served on several ASAE committees and on the Joint Committee for Rural Sanitation, U.S. Department of Health, Education and Welfare.

L. A. Dyke, formerly general export manager of the Oliver Corp., has accepted the position of president of Oliver Australasia Pty. Ltd. in Sydney, Australia. He will continue to serve as vice-president of Oliver International, S. A., in charge of export sales for Australia, Asia, East and South Africa, and the Pacific area.

NECROLOGY

Paul R. Schroeppel, design engineer for J. I. Case Co., Rockford, Ill., died in Rockford Memorial Hospital, December 3, following a long illness.

P. R. SCHROEPPEL

He was born at Mount Carroll, Ill., in 1904, and had lived in Rockford for 48 years. He had been employed as a design engineer for the J. I. Case Company for 29 years.

Mr. Schroeppel was a member of the Lutheran Church, a Star in the East Masonic Lodge 166, Freeport Consistory, and Tebala Shrine. He joined ASAE in 1943.

William G. Hiett has been appointed as agricultural marketing specialist for Marsteller, Rickard, Gebhardt and Reed, Inc., New York, N. Y. Formerly he was with Batten, Barton, Durstine & Osborne, Inc.

Donald H. Malcom, manager of the steel buildings dept. of Armco Drainage & Metal Products, Inc., has been elected chairman of the Metal Building Manufacturer's Association. He was formerly vice-chairman. The Association was formed in 1956 by 13 companies manufacturing standardized steel buildings.

J. P. Schaenzer has been invited to present a paper on farming better electrically in the United States at the Canadian Sectional meeting of the World Power Conference in Montreal, Canada, September 7-11.

W. M. Adair, Jr. formerly with the Willamette Tractor Co., Albany, Ore., is working for the Soil Conservation Service. His first assignment was as unit engineer at Mt. Angel, Ore., and recently he was transferred to Baker, Ore., as area engineer.

John H. Wessman has resigned from the International Harvester Co. to accept a position with a newly formed company, Ocean Minerals. His job will be to help establish plants, set up sales and distribution channels and promote the products (minerals for fertilizer and animal feed extracted from sea water).

Gerald A. Fitzgerald has been appointed as professor of food engineering in the agricultural engineering dept. of the University of Massachusetts, Amherst. Formerly he was consulting engineer for food industries. He received a B.S. degree in 1923 from the Massachusetts Institute of Technology in food engineering, and took graduate studies at MIT in 1924 and at George Washington University in 1926-27.

Merlin Hansen, chief engineer, New Products, John Deere Research and Engineering Center, Waterloo, Iowa, has been named as a vice-president representing tractor and farm machinery activities for the Society of Automotive Engineers, Inc. for 1958.

Cernyw K. Kline has joined the staff of the new agricultural engineering dept. at the University of Kentucky as an extension agricultural engineer. He will continue his interest in the family owned Farm Engineering Service at Mendon, Mich.

Edward G. Molander, agricultural engineer with the U.S. Department of Agriculture, retired recently after completing a 29-year career of federal service.

Specializing in farm structures, Mr. Molander, had been assigned to the Agricultural Engineering Research Division in the Agricultural Research Service of USDA since 1933, except for three years during World War II when he served as assistant regional engineer with the Defense Plant Corp. He has conducted studies on a wide range of subjects related to structural design of farm buildings.

He served as consulting engineer with the Commodity Stabilization Service and was largely responsible for reviewing manufacturers' plans and specifications for grain bins and flat storages purchased by the Government for use at CSS bin sites. He is highly regarded by both Government and industry representatives with whom he has worked.

Mr. Molander was born in Brooklyn, but educated in Sweden. He received the degree of structural engineer from the Technical College of Stockholm in 1916. He worked at his profession in Sweden for five years after graduation and for private industry in the United States from 1920 through 1928. He joined ASAE in 1947.

EVENTS CALENDAR

January 30-31 — *College-Industry Conference* of the American Society for Engineering Education will be held at the University of Michigan, Ann Arbor, Mich. The theme is on new concepts in the education and development of technical manpower. For more information write to Harold M. Dent, chairman, Subcommittee on Invitations, General Motors Institute, Flint, Mich.

February 3-5 — Association of Southern Agricultural Workers, Marion Hotel, Little Rock, Ark.

February 9-15 — Observance of *National Electrical Week*. The objective will be to create a nationwide spotlight on the contributions of electricity and the electrical industry to our American economy and way of life.

February 13-15 — Meeting of the National Society of Professional Engineers will be held at Michigan State University, East Lansing.

February 16-22 — *1958 National Engineers' Week* sponsored by the National Society of Professional Engineers.

February 25-26 — Sixth Annual *National Dairy Engineering Conference,* Kellogg Center, Michigan State University, East Lansing. Sponsored by the agricultural engineering and dairy departments. For more details write Carl W. Hall, Agricultural Engineering Dept., Michigan State University, East Lansing.

March 16-21 — *1958 Nuclear Congress* will be held at the Chicago Amphitheatre, Chicago, Ill. It is managed by the American Institute of Chemical Engineers and coordinated by the Engineers Joint Council and will include the 4th Nuclear Engineering and Science Conference, 4th International Atomic Exposition, 6th Atomic Energy in Industry Conference, 6th Hot Laboratories and Equipment Conference, and the American Power Conference. For further information write to Engineers Joint Council, 29 West 39th St., New York 18, N. Y.

Washington Section

The Washington Section has scheduled a series of monthly meetings on the theme of predictions of things to come. The following programs have been arranged for the first three meetings of the new year: January 10 — American farms of tomorrow, by Sherman Johnson, chief economist, ARS, USDA; February 14—Agricultural engineers of tomorrow, by Harold E. Pinches, assistant to administrator, ARS, USDA; and March 14—American homes of tomorrow, speaker to be provided by the National Housing Center, Washington, D.C.

Alabama Section

A meeting of the Alabama Section was held at Decatur, Ala., on October 17-18. The morning program on October 17 featured tours of the Alabama Flour Mills and the Wolverine Tube Co. The afternoon program included papers on the agricultural outlook by Foy Helms; equipment and chemicals for weed control by T. E. Corley and V. S. Searcy; 4-H tractor program by J. T. Gaillard; and fuels for farm tractors by F. W. Schwettmann. The day was highlighted with a boat trip on the Tennessee River and a Bar-B-Que dinner served enroute.

Friday morning, following a business meeting, papers were presented on what agricultural engineers can do for Alabama by ASAE Secretary J. L. Butt; a farm wiring workshop by W. R. Walker; plastic pipe for irrigation and water supply by Frank Shy; the role of irrigation in mechanized cotton production by Rex Colwick; and harvesting and storing silage by C. A. Rollo.

Pennsylvania Section

The following officers were elected for the coming year at a meeting of the Pennsylvania Section held October 17 and 18 in Gettysburg, Pa. Chairman, O. C. Lange; vice-chairman, J. A. McCurdy; and secretary-treasurer, W. L. Kjelgaard.

Iowa Section

Sixty-two members and guests were present at the Iowa Section meeting held October 18 at Vic's Tally Ho Restaurant, Des Moines. The program consisted of two papers, one on problems in the design and operation of forage harvesting machinery, by G. Russell Sutherland, and the other on oil seals, application and manufacture, presented by representatives from the Chicago Rawhide Mfg. Co.

The next meeting will be on February 7 and a tour of the Firestone Rubber Co. of Des Moines is planned.

Michigan Section

The Michigan Section held a meeting, October 19, in the Agricultural Engineering Building at Michigan State University. Nolan Mitchell, chairman of the Section, presided and the first topic for discussion was membership in the Section. Suggestions concerning membership in the Society, and recruitment of high school students for agricultural engineering were included.

A tentative program for the winter meeting was presented by T. F. Rice. It was decided to hold the Section's spring meeting at the Howell Boy Scout Camp.

Chicago Section

The Chicago Section of ASAE elected Daniel A. Kitchen chairman for 1958 at its meeting October 21 at the Western Society of Engineers Bldg., in Chicago. He is a member of the staff of Aubrey, Finlay, Marley & Hodgson, Inc., Chicago advertising agency.

Vice-chairmen elected were Tobi Goldolftas, International Harvester Co.; Grant T. Facer, Kaiser Aluminum & Chemical Sales, Inc.; and Donald R. Burrowbridge, Thor Power Tool Co. Kenneth V. D. Fiske, National Safety Council, was elected secretary-treasurer.

J. L. Butt, secretary of ASAE, made a few brief comments, and Frank Andrews reported on the 25th Anniversary of the agricultural engineering department of the University of Illinois. The featured speaker for the evening was S. S. DeForest who gave a talk with the aid of slides, on materials handling equipment for corn belt farms.

North Atlantic Section Executive Committee members and division chairmen met recently in New York City to lay preliminary plans for the 34th annual meeting of the section to be held at Guelph, Ontario, August 24-27, 1958. *(Seated, left to right)* James Turnbull; F. W. Pelkert, chairman; E. A. Silver (representing A. M. Best, vice-chairman); H. N. Stapleton, past-chairman; and *(standing, left to right)* H. J. Hansen, R. O. Martin, N. T. Brenner, and C. G. E. Downing, chairman of local arrangements

ASAE MEETINGS CALENDAR

January 30-31 — PACIFIC COAST SECTION, University of California, Los Angeles, Calif.

February 3-5—SOUTHEAST-SOUTHWEST SECTION meeting, Little Rock, Ark.

February 5 — CONNECTICUT VALLEY SECTION, place not announced.

February 7 — IOWA SECTION, Vic's Tally-Ho Restaurant, 56th and Douglas, Des Moines, Iowa.

February 14—WASHINGTON, D. C. SECTION, USDA, South Bldg., Washington, D. C.

February 15 — OHIO SECTION meeting at the New Idea Division of Avco Mfg. Corp., Coldwater, Ohio.

March 14 — WASHINGTON, D.C. SECTION, USDA, South Bldg., Washington, D.C.

March 28-29 — ROCKY MOUNTAIN SECTION, Engineering Center, Colorado State University, Fort Collins, Colo.

June 22-25 — 51st Annual Meeting, Santa Barbara Campus, University of California, Santa Barbara, Calif.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

Southwest-Southeast Sections

The Southwest and Southeast Sections are meeting jointly in the Lafayette Hotel at Little Rock, Ark., February 3-5. The general session which will be held the morning of February 3 will include papers on recent developments in atomic energy, by R. R. Edwards; solar energy for agricultural use, by J. J. McDow; and electronics as a tool for the agricultural engineer, by W. M. Cannon. A general session of American Society of Agricultural Workers will be held at the Marion Hotel.

The theme of the program for the Electric Power and Processing and Farm Structures Divisions session Monday afternoon is on engineering tomorrow's meat supply. Papers to be presented will be on farm factory hog production — present practice, by G. A. Furguson; profitable management of buildings and equipment, by Frank Depew; feed handling and processing — from field to feed trough, by James L. Montague, Jr., and problems in the design and layout of commercial feed lots, by John Koester.

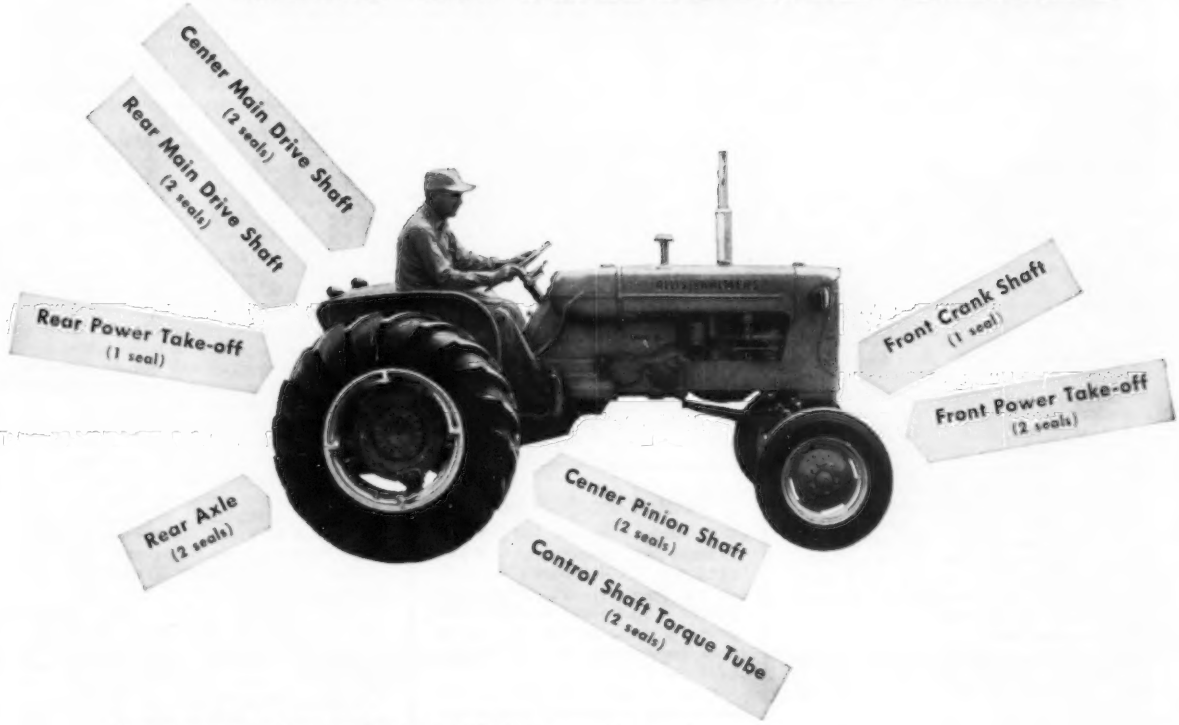
The joint session of the Power and Machinery and Soil and Water Divisions Monday afternoon will include papers presented by Jim McAlexander, on operation of irrigation pumps and motors for greater efficiency; Tom Johnston, on new developments in soil moving equipment; F. E. Edwards, on land drainage and its influence on mechanization; and J. T. McAlister, on recent developments in mulch farming.

The Farm Structures Division and the Electric Power and Processing Division are planning concurrent sessions for Tuesday morning, February 4. Discussions on the aluminum dome — design, cost and advantages; light weight trussed rafters; the agricultural engineer's place in farm housing will be presented during the Farm Structures session. Topics scheduled for the Electric Power and Processing program are on aeration system design for grain storage; outside farm wiring and lighting; and methods for short courses and workshops for vocational agriculture teachers. A general session will follow.

Tuesday afternoon subjects on the equipment and techniques for applying liquid fertilizers; present status of machines for

(Continued on page 42)

NEW! LOOK AT THE 14 POINTS WHERE ALLIS-CHALMERS D-14 TRACTOR RELIES ON NATIONAL SEALS



At 5 positions in the new D-14, Allis-Chalmers specifies steel-encased, spring-tensioned National leather oil seals. Two additional positions employ steel-encased, spring-tensioned Syntech® synthetic rubber seals. At still another position, the control shaft torque tube, a springless rubber-covered National Syntech is used.

All National seals in the D-14 (and many in Allis-Chalmers' equally new D-17 tractor) are standard design National seals. National supplies over 2,500 different types and sizes of oil seals, leather or synthetic. New seals are being designed daily to meet special applications.

For factual, professional engineering help on any shaft sealing problem, call your National Applications Engineer. He's listed in the Yellow Pages, under "Oil Seals—National Seal Division." He's backed up by 36 years of sealing experience, and the productive capacity of three modern plants.

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General Offices: Redwood City, California; Plants: Van Wert, Ohio, Downey and Redwood City, California

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. . . With ASAE Sections

(Continued from page 40)

application of chemicals for weed control; engine design and performance as related to tractor fuels; the use of similitude in agricultural engineering research and Eastern U.S. 4-H tractor program will be included on the Power and Machinery program. Concurrently the Soil and Water Division will present topics on ground water recharge in Arkansas; Six Mile Creek watershed; drouth studies in the Southeast and evaporation studies from farm ponds.

A student program will also be held Tuesday afternoon followed by a banquet in the evening. Earl D. Anderson, president of ASAE, will be the guest speaker for the dinner.

Wednesday morning, February 5, Rush E. Choate will speak on our professional responsibilities and J. L. Butt, secretary of ASAE, will discuss the professional progress in agricultural engineering. Business meetings for each section will close the meeting.

Virginia Section

A meeting of the Virginia Section was held November 15-16 at the Virginia Polytechnic Institute in Blacksburg, Va. Papers presented during the morning meeting, Friday, November 15, were on the uses of plastics in agriculture, by C. E. Staff; watershed development in Virginia, by C. M. Jones; and egg cooling, by R. J. Krueger. The afternoon session opened with a discussion on the Ford typhoon, by R. L. Erwin, followed by E. T. Swink speaking on the College Division program, enrollment and opportunities for graduates; and J. B. Rose telling of the activities of the VPI student branch of ASAE. Papers were also presented on wagon drying of farm crops by J. W. Weaver, Jr., and on land drainage on the Eastern shore, by John N. Selby. The afternoon closed with a panel discussion on the agricultural engineering extension program and a paper on the opportunities for reducing chore labor on dairy farms. A dinner meeting was held at 6:45 with Earl D. Anderson, president of ASAE, as the speaker.

The morning session, November 16, was devoted to a business meeting with G. B. Duke, chairman of the Virginia Section, presiding.

A ladies program was arranged for Friday afternoon at the faculty center. It included luncheon and a bridge and canasta party.

Quad City Section

The Quad City Section held a dinner meeting November 22 at the Tower, 30th Ave. and 7th St., Moline, Ill. Wayne Worthington, John Deere Engineering and Research Center, spoke on a new tool in world trade — the international standards organization; and Homer Brethauer of Martin Implement Sales Co., Orland Park, Ill., discussed agriculture in Russia.

The Quad City Section will hold a technical series of four lectures in the Iowa-Illinois Gas and Electric Company auditorium in Rock Island, Ill., January 31 and February 7, 21 and 28 from 8:00 p.m. to 10:00 p.m. The topic to be discussed will be on power transmission phases of product design.

Bearing and seals design will be discussed by N. F. Andrews, project engineer, John Deere Co., Des Moines Works, Warren Rasmussen, design engineer for Chicago Rawhide Mfg. Co., and George Raley, engineer for Fafnir Bearing Co., on January 31. February 7, C. W. Genson, consulting engineer for J. I. Case Co., Churubusco Works, will talk on gear design. Al Poehlman of Gates Rubber Co. and Edwin A. Paul, chief product engineer for Roller Chain Div. of Chain Belt Co., will speak February 21 on V-belt and chain drives design, and on February 28 Robert Ludwig, chief engineer for the Dana Corp., will lecture on clutch design.

Pacific Northwest Section

The following officers for 1958 were elected at the Pacific Northwest Section meeting held at Pullman, Wash., October 23-26. Chairman, J. B. Rodgers; vice-chairmen, W. H. Knight, George Calver, and L. R. Swarner; and secretary-treasurer, C. A. Root.

Section Project Ideas

The Michigan Section has ordered 245 one-year subscriptions to AGRICULTURAL ENGINEERING for each of the vocational agriculture high schools in the state of Michigan. This project is made possible by a grant from the Michigan Vitrified Tile Co., Corunna, Mich.

Other Sections interested in this project may obtain more information by writing to ASAE Headquarters, St. Joseph, Mich.

Ohio Section

The Ohio Section held a meeting November 8 and 9 at Ohio State University, Columbus. The general theme of the meeting program was on problems in the harvesting and storage of forage crops. Topics covered were on analysis of problems of various methods of handling forage crops, by R. C. Miller; problems in the design and operation of forage harvesting machinery, by Russell Sutherland; problems inherent in the handling of forage crops, by Roger Asmus; and a progress report on activities of the agricultural engineering dept. of OSU, by R. D. Barden. A movie, entitled "A Place in the Sun" and a discussion of problems in the production of visual aids were presented by W. Everett Eakin.

C. L. Blackman spoke on experiences of an American agricultural educator in India at the Section banquet Friday evening. A paper on problems involved in hay storage was presented by J. R. McCalmont and a talk on problems involved in silage storage was given by Arnold Morse Saturday morning.

Saturday afternoon a football game between Ohio State and Purdue was enjoyed by the football fans.

A look at the future of agriculture will be the general theme of the winter meeting of the Ohio Section, February 15. The all day meeting is being held this year at Coldwater, Ohio, with engineers from New Idea Division of Avco Mfg. Corp. acting as hosts.

R. C. Evans, chairman of Ohio Section and New Idea product manager, stated that the morning program will include a tour of New Idea's engineering and manufacturing facilities followed by a luncheon.

The afternoon program will be keynoted with an address by Karl Butler, farm counselor for Avco Mfg. Corp. His topic will be, "What's Happening to Agriculture?" A panel discussion entitled, "Surveying the Future of Agriculture" will be moderated by Russell R. Raney, director of engineering. Representatives from the fields of finance, research, industry, education and farming will participate on the panel.

Panel members include Paul Hinkle, superintendent of Ohio banks; Blair Williams, assistant general manager of New Idea-Avco; Franklin Smith, owner and operator of Lawn View Stock Farm in Groveport, Ohio; Walter M. Carleton, assistant director, AERD, ARS, USDA; and R. D. Barden, chairman, agricultural engineering dept., Ohio State University.

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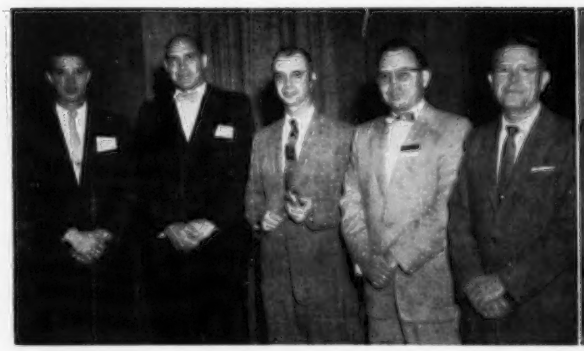
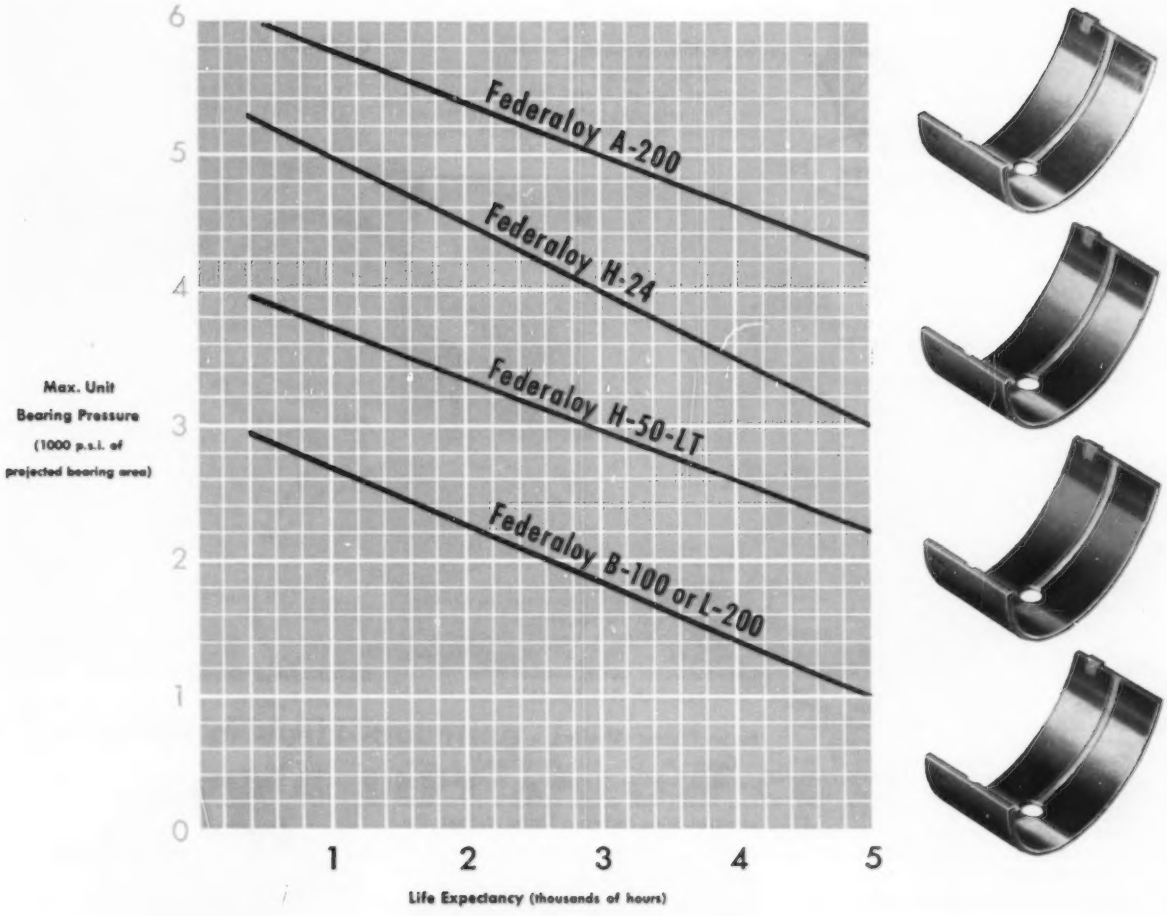


(Left) The Pacific Northwest Section officers for the coming year are (LEFT TO RIGHT) Frank Leitz, student, State College of Washington, 4th vice-chairman; L. R. Swarner, 3rd vice-chairman; J. B. Rodgers, chairman; W. H. Knight, 1st vice-chairman; and C. A. Root, secretary-treasurer. • *(Right)* Karl D. Butler (CENTER) is welcomed as keynote speaker for the winter meeting of Ohio Section by committee members for the meeting. (LEFT TO RIGHT) D. D. Cerny, program chairman; J. R. Beebe, Dr. Butler, R. R. Raney and D. R. Scheffler



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Rain Gage

M. C. Stewart, Manufacturer, has announced a weather station type universal rain gage for measuring all forms of atmospheric precipitation. It is said to be easy to install and simple to use by either professional or amateur observer. Other features include an optimum size and type of receiver which secures accurate representative "catch" of precipitation under widely varying conditions of wind, weather and exposure site; measurement of collected precipitation is done indoors, thus there is no loss, no mistakes, spilling or other inconvenience when tending gage in bad weather or at night; a one point, tubular ground stake which holds entire assembly; a ground pull-up rope may be used on stake for easy removal of temporary installations; and a laboratory type cylindrical graduate is used for precise volumetric measurement, to internationally accepted standards, of precipitation caught. Attachments are available for adding-on evaporation gage, atmometer, etc.

(For more facts circle No. 64 on reply card)

Truck Grain Blower

Truck Grain Blower Co. has introduced its new model Montana truck-mounted grain and feed blower. Originally the blower was developed for putting small grain into bins and box cars. New attachments have added to its versatility. Attachment of additional pipe permits materials to be lifted over 20 ft into bins or overhead feed hoppers. A new horizontal attachment uses a flex hose to fill range or feedlot feeders. A simple dust collector is added for handling ground feeds.

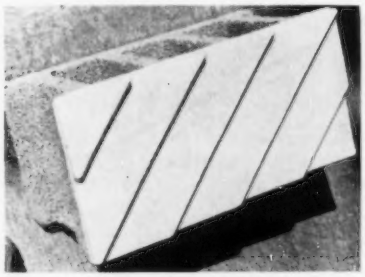
The blower can be operated with the truck in motion or standing still — can be used as a broadcast seeder, for improving pastures or controlling erosion, or for scattering scratch grain to poultry on range. The blower is said to fit any make truck or pickup, is driven by PTO and V-belts, and reportedly unloads 90 to 100 bu of grain or pellets in 10 min.

The same basic blower unit can be installed on the front of a farm wagon or trailer, with power from tractor PTO or belt, or used as a stationary unit with hoist-equipped trucks.

(For more facts circle No. 65 on reply card)

Concrete Surface Forms

Portland Cement Association has announced that an almost limitless variety of new textures and patterns for concrete surfaces has been made possible by development of plastic and rubber form liners. The



new liners are said to produce sharp, crisp patterns and a smooth, almost glassy surface that requires no cleandown, grinding or finishing.

The liners are also satisfactory for facing concrete block, producing either a pattern for variety in wall surfaces or a smooth, glossy surface much like glazed block. Both the plastic and rubber form liners are said to be reusable many times if handled carefully, need no form oil or bond breaker, and require no special concrete mix.

(For more facts circle No. 66 on reply card)

New Picker-Sheller

Deere & Co. has introduced a new mounted corn picker-sheller designed for field installation on the Model 227 two-row mounted corn pickers. Drive is from the

tractor PTO and shelled corn is delivered directly into a trailing wagon. The sheller is interchangeable with the wagon elevator, so that part of the crop can be picked as ear corn if desired.

(For more facts circle No. 67 on reply card)

New Combine Corn Heads

Allis-Chalmers Mfg. Co. has announced two new 2-row corn heads for snapping and shelling corn to fit Model 66 All-Crop harvester and Gleaner Baldwin Model A self-

propelled combines. The corn heads for both machines are similar in basic design. Each has low sloping snouts for all types of corn and adjustable stripper plates over the rolls. The attachments are removable from both machines and supported in remounting position by convenient mounting jacks which are standard equipment.

(For more facts circle No. 68 on reply card)

Combine Attachment

International Harvester Co. has developed a new two-row corn unit for the No. 101 self-propelled harvester-thresher. The new

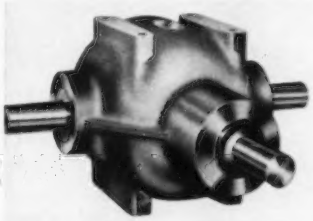
unit replaces the regular 10-ft grain platform to convert this medium-sized combine into a field sheller. A storage stand holds the harvesting and shelling attachment in position so all the operator has to do is detach the grain platform, drive the separator into position, and attach the corn unit.

In operation, the corn feeds in through gathering units where ears are snapped from the stalk when they come in contact with stripper plates located above the fluted rolls; the stalks feed through the rolls and fall to the ground without going through the thresher. The ears are dropped onto a big, centrally located, grain-tight conveyor which delivers the ears parallel to the cylinder.

(For more facts circle No. 69 on reply card)

Bevel Gear Drive

Durst Foundry and Machine Works has developed a new all-position bevel gear drive. This bevel gear drive has a ratio of



16 to 28 and is designed for tractor PTO, for farm machinery or similar applications. Two sets of mounting lugs make it possible to mount on either side for changing the direction of rotation.

The drive is equipped with Timken roller bearings and grease seals. Standard model shafts are all 1½-in. dia with ⅜-in. keyways. The shafts, however, may be cut down to smaller sizes and keyways or splines supplied as required. The approximate weight of the unit is 78 lb.

(For more facts circle No. 70 on reply card)

Adds Loader-Backhoe to Line

J. I. Case Co. has added the new 310 tractor-loader-backhoe unit to its line of farm machinery. The unit was introduced

to open new markets as represented by contractors, cities, counties and others in need of low-cost construction and loading equipment.

(For more facts circle No. 71 on reply card)

And new 70-bushel McCormick No. 21 spreads this big load in a hurry, too! It rips hard-packed manure to pieces and spreads it uniformly. Treated wood box with steel flares and rugged frame for long life.

Quick drive-in mounting . . .

BIG LIFT at LOW COST

with the New McCormick® No. 33 Loader!

Ram-in loading—even with a 50 hp tractor—doesn't strain this new low-cost McCormick No. 33 loader. And all-welded frame, sturdy bracing, and closer-coupled, single-unit design also give the No. 33 loader strength to lift a ton nearly 10 feet high. Split-second control, 3,000-lb breakaway lift, and big 9-cubic-foot fork help you load 70 bushels in only 9 or 10 passes to cut manure moving time.

And you just drive in to mount the No. 33 loader in about 12 minutes. Parking legs, which hold the loader at proper height for fast mounting, become front braces. The rugged No. 33 loader mounts on International® 350 and 330 Utility tractors; Farmall 450, 350 and earlier models.

Save trips with new McCormick 95-bushel spreader. 108 self-cleaning beater teeth help new McCormick No. 30 spreader shred manure more thoroughly. Your choice of ground or pto drive.

Ask your IH dealer

to demonstrate McCormick No. 33 loader features that save time and work. Figure cash savings in first cost and operation that come with a McCormick loader and spreader that *exactly* fit your manure moving needs.

See your

INTERNATIONAL HARVESTER Dealer

International Harvester Products pay for themselves in use — Farm Tractors and Equipment . . . Twine . . . Commercial Wheel Tractors . . . Motor Trucks . . . Construction Equipment—General Office, Chicago 1, Illinois.

IH®

For more facts circle No. 46 on reply card

. . . With ASAE Sections

(Continued from page 42)

Tennessee Section

The fall technical meeting of the Tennessee Section was held at the Hermitage Hotel in Nashville, Tenn., November 22 and 23. Fifty were in attendance and guest speakers included Earl Anderson, president of ASAE; R. R. Poyner, International Harvester, Chicago; J. B. Stere, New Holland, Pa., and Henry Marks, Ewing Foundry, Inc., Indianapolis. They spoke, respectively, on fifty years of reducing the odds, seedbed preparation and seeding, grain and crop drying, and drying with supplemental heat. Other topics discussed were on land forming for better farming, by R. L. Lester; the USDA small watersheds program, by H. N. Estes; methods of instruction, by W. R. Walker of TVA; future plans for the University of Tennessee agricultural engineering dept., by C. W. Bockhop, head of agricultural engineering dept.; coordination of agricultural engineering program of Middle Tennessee State College with University of Tennessee, by Clarence Chesnutt, Jr., Middle Tennessee State College; and natural air drying, by Ed Hale.

Panel discussions on crop production and on storage and processing of farm crops were presented.

Section officers for the coming year are: Chairman, J. K. "Farmer" Jones; vice-chairmen, D. H. Luttrell and James A. Neely. Jack G. Lamb was elected secretary-treasurer.

Pacific Coast Section

The Pacific Coast Section will hold a meeting January 30-31 at the University of California in Los Angeles. Austin Armer, chairman of the Section, will preside during the morning program, January 30. Speakers will include L. M. K. Boelter, Maurice Johnson, Douglas Baird, and William Kyle. They will discuss, respectively, engineering education in California and at UCLA, development of a printer for marking lemons, strain gage measurement of forces in a mower, and X-ray detection of frost damaged oranges.

During the afternoon program James Howard and P. F. O'Brien will present a paper on prediction of albumen quality of eggs from photometric measurements; T. A. Rogers on analog computers and Morris Asimow on digital computers. J. L. Butt, secretary of ASAE, will speak on the growth and status of ASAE. A business meeting will close the afternoon session.

W. C. Lowdermilk is scheduled to be the speaker for the annual dinner. His topic will be "Extending the Hand of Agriculture."

Friday morning, January 31, the determination of radiation shape factor from orthographic projections will be discussed by S. A. Hart; summer heat control for small homes will be presented by R. D. Cramer and L. W. Neubauer; field experience in measuring hydraulic conductivity will be discussed by Al Klinge and determination of tile drain spacing by J. D. Isherwood. A. F. Pillsbury will discuss wetting expansion of draintile, and effect on water entry; and C. H. Sortor will speak on photographic inspection of deep wells.

A luncheon will close the meeting. Harvey Banks will give the luncheon address on California water needs.

Officers of the Tennessee Section of the American Society of Agricultural Engineers display the Society's emblem. *(Left to right)* J. L. Montague, Jr., retiring chairman; R. L. Lester, program chairman; D. H. Luttrell, vice-chairman; W. J. Liddell, retiring vice-chairman; and J. K. (Farmer) Jones, chairman.

Winter Meeting High Lights

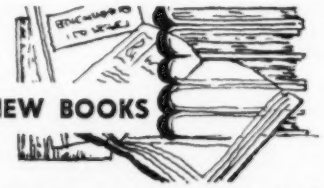
(Continued from page 36)

Farm Work Efficiency program and the Extension Brainstorming session. Subjects discussed on the Farm Work Efficiency program were on energy expenditure and farm work efficiency, by W. H. M. Morris; vibration as a psychological factor in work efficiency, by M. Schmitz; and sociological aspects of farm work efficiency, by R. L. Eichorn. The Extension Brainstorming session consisted of a demonstration by J. A. Hopkins, Ethyl Corp., on the technique of brainstorming, or creative thinking by groups.

More than 500 agricultural engineers and research workers from the farm equipment industry, state agricultural colleges, and public research agencies were in attendance at the annual dinner sponsored by the Agricultural Research Committee of the Farm Equipment Institute, held Tuesday, December 17. This dinner has been a highlight of the Winter Meeting of the American Society of Agricultural Engineers over the years, and has contributed to the good relations and understanding between public research workers and agricultural engineering professors at state agricultural colleges, and engineering and research workers of the farm equipment industry.

During the dinner the 1957 FEI Gold Awards were presented to William J. Coultas of Deere and Company, East Moline, Ill., and Charles J. Scranton of Allis-Chalmers Mfg. Co., LaPorte, Ind., for outstanding engineering contributions to agriculture, industry, and the Institute.

Helmut E. Landsberg, director, Office of Climatology, Weather Bureau, Washington, D.C., was the dinner speaker. His address was entitled "Looking Ahead at the Weather."



Managing Southern Soils, by H. B. Vanderford. Cloth, 5½ x 8½ inches, xi + 378 pages, illustrated and indexed. Published by John Wiley & Sons, Inc., New York, N.Y. $4.75.

This book has been prepared primarily for agricultural students, farmers and farm leaders who are interested in the management of southern farm soils. Emphasis has been placed on the what, how, and why of actual farm operations, with limited attention given to technical terms, processes, and explanations. The author has held to the basic materials of soil science in describing the nature and properties of soils and the well-tested soil management practices. Each phase of soil management has been treated in relation to the economic production of the major crops grown on southern farms. Several chapters are devoted to fertilizing, liming, controlling erosion, and conserving soil water. Attention has also been given to land judging and to the selection of soils for different uses. Special problems of buying farm land have been considered, with reference to the interest and needs of young farmers.

Fundamentals of Mechanical Design, by Richard M. Phelan. Cloth, 6 x 9 inches, ix + 526 pages, illustrated and indexed. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y. $8.75.

This book is primarily written as a textbook and emphasis is placed on what can be done, what principles are involved, and where one can find the additional detailed information that may be required in the actual design or selection of mechanical elements or a machine. The coverage is broad, especially in relation to mechanical components such as couplings, clutches, and variable-speed drives that are often purchased as complete units and incorporated into machines.

Some handbook information is included to acquaint the student with the types of information available in handbooks and catalogs. There are illustrations of actual parts and machines, and multipurpose problems are provided in the back of the book.

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For more facts circle No. 47 on reply card

MANUFACTURERS' LITERATURE

Peg-Board Fixtures

Masonite Corp. — A catalog of peg-board fixtures and prices. A complete list with specifications for fixtures, shelves, dispensers and panels is included.

(For more facts circle No. 72 on reply card)

Stampings Folder

Stamping Div. of Transue & Williams — A 6-page folder illustrating the stampings produced by the company for a variety of industries, from parts for the electronics industry to automatic pinsetting machines for bowling alleys.

(For more facts circle No. 73 on reply card)

Portable Elevator

Allis-Chalmers Mfg. Co.—A folder which describes and illustrates the Flight-Line portable elevator. A table for determining the length of elevator and a list of elevator specifications are included.

(For more facts circle No. 74 on reply card)

Electronic Resistance Thermometer

Barber-Colman Co. — Data sheets illustrating and describing an electronic resistance thermometer. Specifications and components are also included. The thermometer features an indicating meter, a bridge and power supply and as many sensing elements and selector switches as are necessary to remotely check temperatures at all control points required for each application.

(For more facts circle No. 75 on reply card)

Cutting Tool Units Catalog

Beaver Tool and Engineering Corp.—This 49-page catalog No. 57 illustrates and describes the company's cutting tool units, bars and grinding fixtures.

(For more facts circle No. 76 on reply card)

Rotating Shaft Seals

Rotary Seal Division, Muskegon Piston Ring Co. — A 10-page brochure, entitled "Solving the Problem of Seals for Rotating Shafts" describing various sealing problems in machine design and solutions. Rotary seal components are also included.

(For more facts circle No. 77 on reply card)

Barn Cleaner

Clay Equipment Corp. — Bulletin No. BC-301 illustrates and describes the components of a new barn cleaner. Features include all-weather protection, new friction release, heat treated forgings, paddles welded to flat links, flexible chain, and more bearing area.

(For more facts circle No. 78 on reply card)

Corrosion Resistant Lubricant

Electrofilm, Inc.— Technical Bulletin No. 2055 contains information about a one-coat corrosion resistant solid film lubricant. It is described as a built-in dry film lubricant for operation in temperatures ranging from −65 F to 600 F, and also for high loads and high speeds.

(For more facts circle No. 79 on reply card)

Equipment Lubrication Guide

Whitmore Mfg. Co. — A new folder to serve the mining, construction, and manufacturing industries as a reference in determining the correct lubricant to use for specific equipment application and for varying seasonal temperatures. More than 40 different lubricants are described.

(For more facts circle No. 80 on reply card)

Straw Chopper

Innes Company — This 4-page brochure concerning the company's straw chopper describes the following features: curved action blades, hammer bearings, 3-way adjustment, easily adjustable retarder knives, smooth action, self-aligning sealed ball bearings, adjustable saddle, and balanced tension.

(For more facts circle No. 81 on reply card)

Hydraulic Cylinders

Densmore Engineering Co., Inc. — A 4-page folder containing illustrations and specifications of the company's hydraulic cylinders, from 2 to 4-in. bore and 8 to 18-in. stroke. Features of the cylinders include bronze wiper ring, chrome plated piston rods, cast steel clevis, etc. A separate price list sheet is also included.

(For more facts circle No. 82 on reply card)

Husking Rollers

A. Lakin & Sons, Inc. — This folder carries an outline showing a selection of husking rollers for various picker models. It also includes instructions for installing the roller and lists built-in extra features for the husking rollers.

(For more facts circle No. 83 on reply card)

Electric Brakes

Warner Electric Brake & Clutch Co. — A 36-page illustrated report of the company's electric brake for design engineers. It includes photographs, drawings, diagrams, and an explanation of operation, selection factors, torque characteristics and controls.

(For more facts circle No. 84 on reply card)

2-cylinder models 10 to 18 hp.
4-cycle single cylinder 3 to 12 hp.
The Weather is never
TOO HOT nor
TOO COLD for...
Note large capacity flywheel fan
WISCONSIN Heavy-Duty
Air-Cooled ENGINES
V-type 4-cylinder models, 15 to 56 hp.
Working at any temperature from low sub-zero to 140° Fahrenheit . . . Wisconsin Engines will keep your equipment going efficiently and economically with the least amount of attention.
AIR-COOLING, as supplied on all Wisconsin Engines (3 to 56 hp.), automatically takes care of all your cooling problems. Nothing to freeze in cold weather; no radiator dry-ups in hot weather.
AIR-COOLING prevents costly engine failures and replacements such as occur when the cooling system of a water-cooled engine is neglected. Eliminates up to 26 separate parts that are generally required for a water-cooled engine. One simple casting, which is a part of the flywheel itself, provides continuous, correct cooling on all Wisconsin Engines.
In addition, you get the benefits of basic load-holding High Torque, heavy-duty construction in all details and the advantages of exclusive specialization in the design and manufacture of AIR-COOLED Engines . . . plus convenient servicing when required, through Wisconsin Authorized Distributors and Service Stations.
It will pay you to specify Wisconsin Air-Cooled Engine Power for your equipment! Write for free copy of Wisconsin Engine Bulletin S-223.
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—making the job easier for the man who rides a tractor

Power steering is every bit as desirable for farm tractors as it is for passenger cars—*and for more and better reasons.*

By taking the tiresome muscle work out of steering, it makes tractor work not only an easier task but a far more efficient operation.

For example, power steering eliminates wheel fight and shock even over the roughest ground; it permits the tractor to be controlled by simply "pointing" where the driver wants it to go.

Also, short turns become an easy, one-hand job even when the tractor is standing still.

Any way you look at it, power steering saves time as well as work, and that's exactly why power steering on farm tractors is destined to be the next step forward in farming efficiency.

Bendix* Power Steering is a performance-proven product designed and engineered by Bendix, foremost producer of power steering and brakes for the automotive industry.

It is used with a conventional steering gear and is adaptable to existing steering linkage, permitting tractor manufacturers to make production-line installations without costly or extensive engineering changes.

Manufacturers interested in adding Bendix Power Steering to their present list of sales features are invited to write for further details to BENDIX PRODUCTS DIVISION, SOUTH BEND, INDIANA. *REG. U.S. PAT. OFF.

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Bendix PRODUCTS DIVISION South Bend, IND.

Bendix AVIATION CORPORATION

For more facts circle No. 48 on reply card

The good name of your machine is LINK-BELT's first consideration . . . TRADE MARK . . . and quality should be your first consideration in the chain you buy

McCormick No. 163 self-propelled windrower uses Link-Belt roller chain and sprockets and flexible couplings.

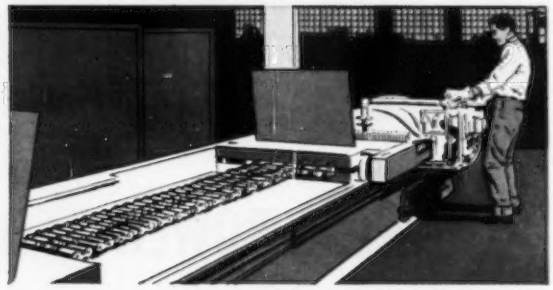
Be sure you specify drive and conveyor chain with

the quality your design deserves

Use LINK-BELT chain . . . built to top farm machine standards as determined by field and lab tests

LINK-BELT'S recommendation of the best drive or conveying chain for your machine is based on experience gained in field tests under actual working conditions. And Link-Belt is in the best position to make unbiased proposals because our line of chain, sprockets and attachments is *complete*. Horsepower, loading, speed, impact—every requirement can be met to enable your machine to maintain rated performance and efficiency throughout its life.

Yes, Link-Belt's unmatched facilities, experience and services are your best assurance of quality chain, properly applied. Next time you're considering a drive or conveyor application, our chain specialists will be glad to work with your engineers. For facts and prompt service, call your nearby Link-Belt office.



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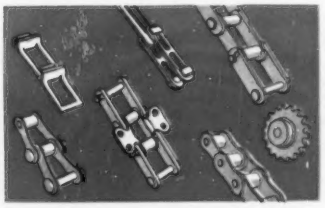
CHAINS AND SPROCKETS



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☐ I would like information about membership in the American Society of Agricultural Engineers, including an application form. (I understand that a subscription to AGRICULTURAL ENGINEERING and a copy of AGRICULTURAL ENGINEERS YEARBOOK are included in the annual dues of ASAE members.)

☐ I am an ASAE member and suggest that membership information, including application form, be sent to the name and address below. I can supply names of _____ more prospective members. My name is _____

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City _____ **Zone** _____ **State** _____

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2	12	22	32	42	52	62	72	82	92
3	13	23	33	43	53	63	73	83	93
4	14	24	34	44	54	64	74	84	94
5	15	25	35	45	55	65	75	85	95
6	16	26	36	46	56	66	76	86	96
7	17	27	37	47	57	67	77	87	97
8	18	28	38	48	58	68	78	88	98
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5	15	25	35	45	55	65	75	85	95
6	16	26	36	46	56	66	76	86	96
7	17	27	37	47	57	67	77	87	97
8	18	28	38	48	58	68	78	88	98
9	19	29	39	49	59	69	79	89	99
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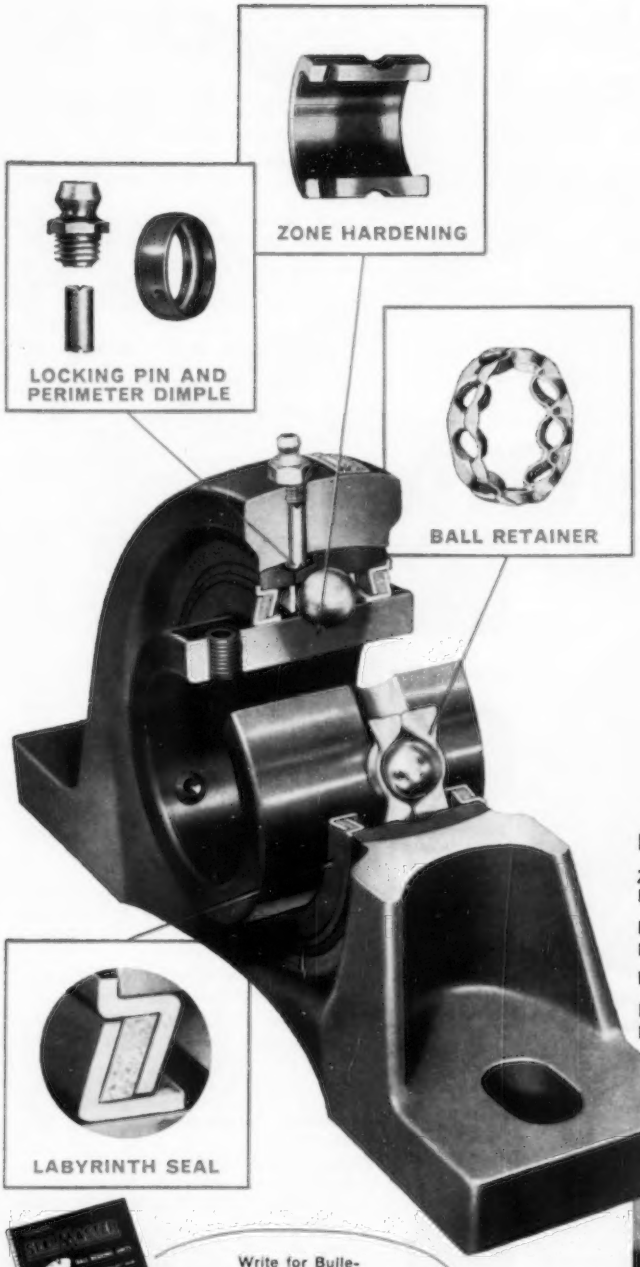

THIS EXCLUSIVE COMBINATION OF FEATURES IS YOURS WITH SEALMASTER BALL BEARING UNITS ... PLUS QUICK, EASY MOUNTING!

Slip a SEALMASTER Ball Bearing Unit into place on the shaft—tighten two set screws and you have the answer to ease of mounting in a bearing unit. SEALMASTER'S exclusive combination of features take over from there, providing smooth, trouble-free performance and long bearing life.

FEATURES:

ZONE HARDENING . . . assures positive race-to-shaft holding power.

LAND RIDDEN BALL RETAINER . . . traps grease and prevents "churning."

LABYRINTH SEAL . . . keeps dust and dirt out, lubricant in.

LOCKING PIN & PERIMETER DIMPLE . . . assures positive lubrication.

Write for Bulletin 454 for full information.

SEALMASTER®

BALL BEARING UNITS

SEALMASTER BEARINGS A DIVISION OF STEPHENS-ADAMSON MFG. CO. 67 RIDGEWAY AVENUE, AURORA, ILL.

For more facts circle No. 50 on reply card

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Adams, Robert N. — Grad. res. asst., agr. eng. dept., agr. exp. sta., University of Florida (Mail) 1124 N.W. 4th Ave., Gainesville, Fla.

Badger, Edson R. — On duty with armed services. (Mail) 2304 Hoover, Apt. C, Lawton, Okla.

Bekker, Mieczyslaw G. — Tech. dir., Land Locomotion Res. Br., R & D Div. Ord. Tank Autom. Command. (Mail) 1136 Maryland Blvd., Birmingham, Mich.

Bell, Raymond E.—Asst. spec., rural bldgs., ext. serv., Oklahoma State University, Stillwater, Okla.

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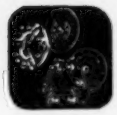
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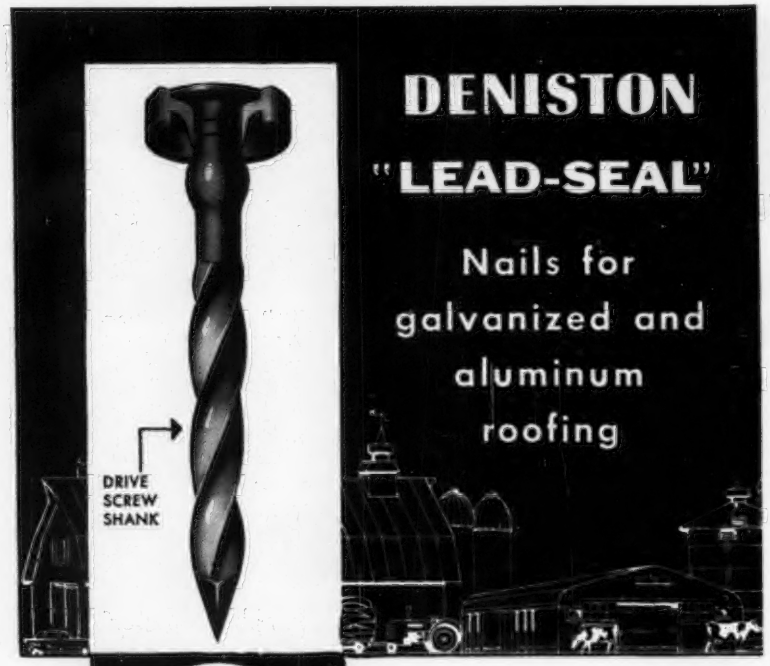

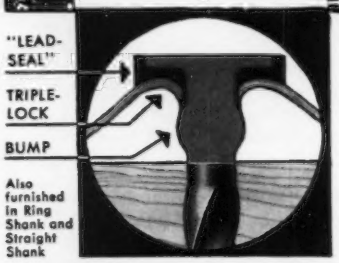

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NOTE: In this bulletin the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this Bulletin, request form for Personnel Service listings.

POSITIONS OPEN—JUNE—O-189-729, 170-730. AUGUST — O-183-734, 196-735, 248-736, 255-737, 259-738. SEPTEMBER — O-267-741, 267-742, 267-743, 267-744, 292-746, 284-747, 284-748. OCTOBER — O-272-749, 334-750, 334-751, 339-752, 339-753, 336-754, 314-755. NOVEMBER — O-350-756, 350-757, 360-758, 369-759, 362-760, 379-761, 380-762. DECEMBER — O-385-763, 386-764, 387-765, 412-766, 370-767.

POSITIONS WANTED—JUNE—W-186-11, 171-12, 180-13, 190-14. JULY—W-193-15, 192-16, 238-17. AUGUST—W-206-18, 254-22, 239-23, 256-25, 261-26. SEPTEMBER—W-278-27, 276-28, 262-29, 286-32, 299-33, 290-34. OCTOBER — W-289-35, 326-36, 335-37, 331-38, 340-39, 341-40, 301-41, 297-42. NOVEMBER—W-337-43, 320-44, 344-45, 356-47, 357-48, 342-49, 291-50, 363-51. DECEMBER — W-371-52, 378-53, 394-54, 405-55, 409-56, 415-57.

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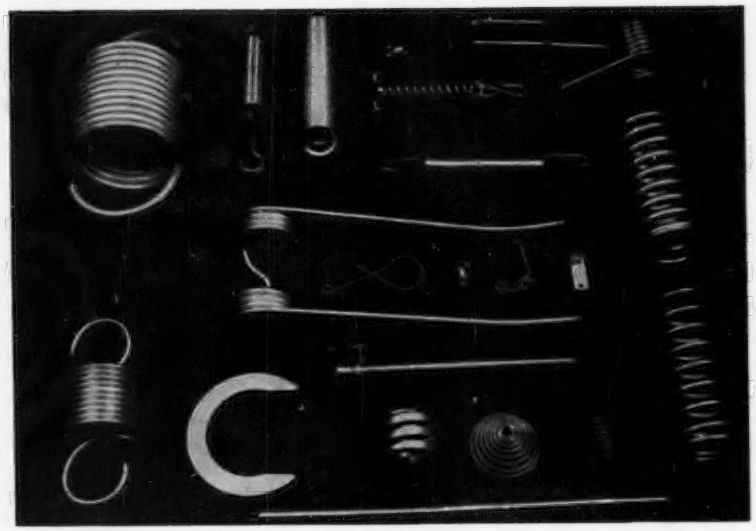

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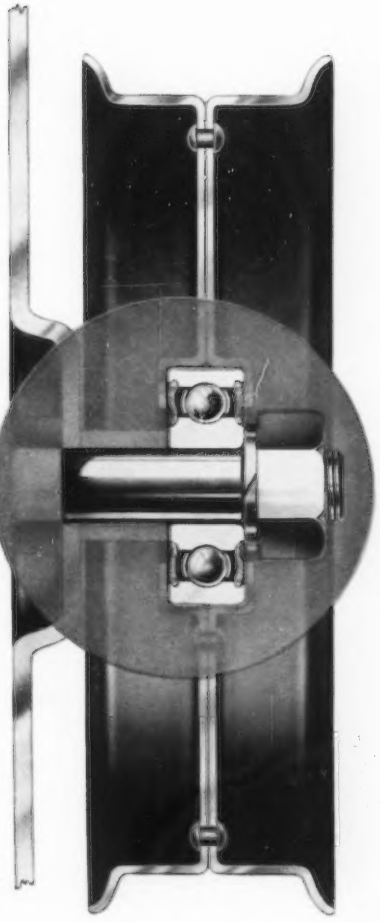

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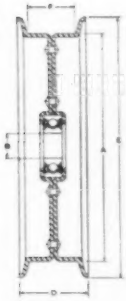

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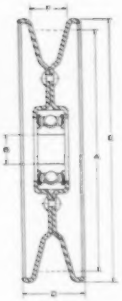
*Idler unit PF2-212 is hardened to provide long life when used on chain drives.
**Standard machine bolt, hex head recommended.



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1908–1958 GM FORWARD FROM FIFTY

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DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

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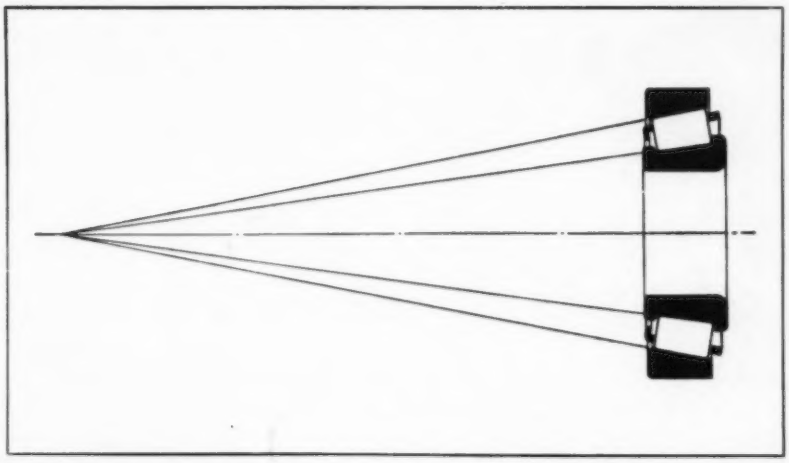
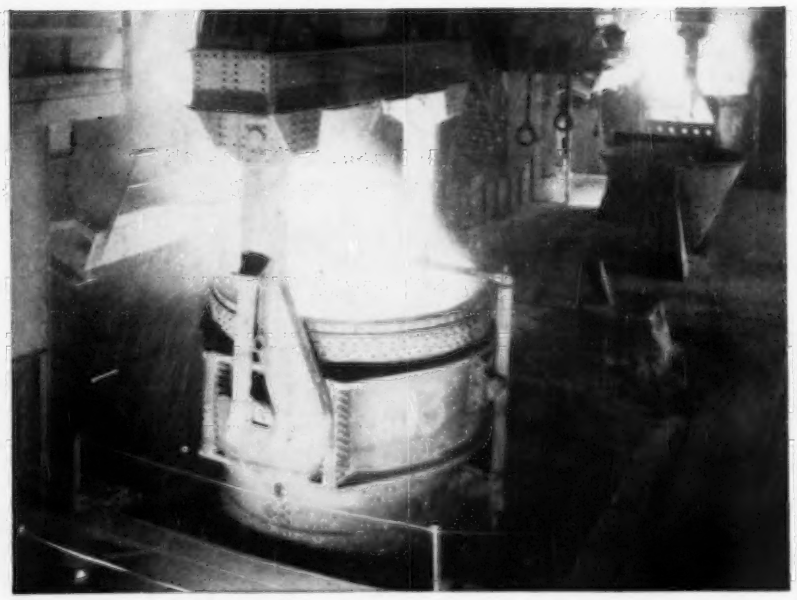
ONLY TIMKEN BEARINGS ROLL SO TRUE—All lines drawn coincident with the working surfaces of the rollers and races of Timken® tapered roller bearings meet at a common point on the bearing axis. This means Timken bearings are geometrically designed to have true rolling motion. And they're made with microscopic accuracy to live up to their design. They roll true for years, for miles and miles, under toughest service conditions.





WE START BY MAKING OUR OWN STEEL—To insure finest bearing quality, we make our own electric furnace fine alloy steel. We're America's only bearing manufacturer that does. And we take many more quality-control steps to make Timken bearings live up to their design. For example, they get over 100 inspections to assure top accuracy and performance. We even developed equipment that measures surface smoothness to millionths of an inch—use gages that measure the thickness of a molecule to keep production gages at top accuracy.

FIELD ENGINEERING SERVICE—Timken Company Field Engineers will gladly go over your farm machine design and application drawings with you—show you which Timken bearings will give you the greatest economy. We'll recommend the Timken bearings that will help give your farm equipment the best performance at the lowest possible cost. For more information, write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

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